

FEASIBILITY STUDY

EAST LAKE

SITE PREPARATION

Prepared for **Environment and Sustainable Development Directorate**

Prepared by

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EXECUTIVE SUMMARY

EAST LAKE SITE PREPARATION FEASIBILITY STUDY

Executive Summary

KEY MESSAGES

- The primary objective of this report is to assess the logistics and evaluate the feasibility of various site preparation options for contaminated and geotechnically unsuitable fill materials previously identified at the Site while considering remediation objectives, technical practicability, and logistical constraints
- AECOM evaluated the following 4 remediation options for the site
 - Option 1 – Clean environmental hotspots, cap uncompacted fill area as required. Management of general geotechnical and environmental issues would be managed by individual Site developers;
 - Option 2 – Remediate the whole of the fill for geotechnical and environmental contamination by excavation, removal of unsuitable materials and replacement of the soil materials as controlled fill; and
 - Option 3 – Clean environmental hotspots and use partial excavation in conjunction with ground improvement such as impact rolling to improve the geotechnical properties of the site followed by adequate controlled fill capping.
 - Option 4 – Revision of the Planning and Design Framework, onsite containment of fill materials and re-use of excavated clean fill materials.
- Analysis of the above site preparation options indicated that Option 4 was potentially the most suitable option based on the high re-use potential of materials within the site and the reduced requirement for offsite disposal.
- In parallel to the site preparation options assessment AECOM undertook a cost-benefit analysis (CBA) to provide an economic assessment of each site preparation options which indicated the following:
 - All of the options appear to provide a positive Net Present Value (NPV), with the probabilistic analysis suggesting that 95% of the NPVs will be positive. This is in part due to the high land values of the area containing East Lake.
 - The potential for cost overruns in options 1 to 3 pose the largest risks to a positive NPV being generated from remediation.
- It is therefore the opinion of AECOM that “Option 4” should be considered the most feasible methodology of remediating the site in preparation for subsequent Site sale and development due a combination of financial, social and environmental benefits.

AECOM Australia Pty Ltd (AECOM) was engaged by Environment and Sustainable Development Directorate (ESDD) to prepare a Site Preparation Feasibility Assessment for the site identified as the East Lake Urban Renewal Site (the Site).

The East Lake site is primed for urban revitalisation and contains all the ingredients necessary to showcase the ACT Government’s progressive attitude towards sustainable development and innovation. The project’s success has been identified as the culmination of social, economic and environmental sustainability in creating one of the ACT’s premier development sites.

Previous environmental investigations undertaken within the site identified a range of contaminants (in limited concentrations) throughout a matrix of currently unsuitable fill materials within the proposed development. If unsuitable fill material is simply disposed off-site, the financial cost to the ACT Government (land fill, trucking, etc) could render the project financially nonviable.

To enable the development to proceed and meet ACT Government land release targets, while maximising both its environmental and economic sustainability, solutions must be developed to maximise the beneficial re-use of onsite fill materials.

The primary objective of this report is to assess the logistics and evaluate the feasibility of various site preparation options for contaminated and geotechnically unsuitable fill materials previously identified at the Site while considering remediation objectives, technical practicability, and logistical constraints.

To meet the project objective, AECOM undertook a detailed desktop assessment, site survey and existing site condition constraints analysis. From review of previous investigations, the key site constraints to the proposed development were determined to relate to site contamination, geotechnically unsuitable fill materials and the storm water grading and levels required for development.

Following assessment of existing site conditions AECOM developed the necessary steps/approach to be undertaken for three previously determined Site preparation options and one option developed by AECOM during this assessment;

- Option 1 – Clean environmental hotspots, cap uncompacted fill area as required. Management of general geotechnical and environmental issues would be managed by individual Site developers;
- Option 2 – Remediate the whole of the fill for geotechnical and environmental contamination by excavation, removal of unsuitable materials and replacement of the soil materials as controlled fill; and
- Option 3 – Clean environmental hotspots and use partial excavation in conjunction with ground improvement such as impact rolling to improve the geotechnical properties of the site followed by adequate controlled fill capping.
- Option 4 – Revision of the Planning and Design Framework, onsite containment of fill materials and re-use of excavated clean fill materials.

Following development of Options 1–4, AECOM undertook an analysis of site preparation options against the following key criteria:

- Technical, logistical, timing and financial feasibility ; and
- Sustainability issues associated with onsite re-use, CO2 emissions and community response.

Analysis of the above site preparation options indicated that Option 4 was potentially the most suitable option based on the high re-use potential of materials within the site and the reduced requirement for offsite disposal.

Upon completion of the options assessment, AECOM developed a Development Staging Plan that outlines the necessary processes required to enable development under the preferred Site preparation option. Following information provided by ESDD, AECOM assumed the development will be undertaken in three distinct phases, linked to the distribution of geotechnical and environmental contaminants:

- Phase 1 – Redevelopment of The Causeway located within the north western portion of the Site;
- Phase 2 – Development of the Central portion of the Site; and
- Phase 3-- Development of the southern portion of the Site within the vicinity of the existing railway infrastructure.

In parallel to the site preparation options assessment AECOM undertook a cost-benefit analysis (CBA) to provide an economic assessment of each site preparation options, presented in 7.0.

The objective was to provide economic analysis that can assist ESDD in its overall decision about the preferred remediation option. As such, the CBA results should be viewed as complementary analysis to the other engineering and environmental work undertaken for this project.

The CBA was undertaken using an analysis developed specifically for the purposes of this project, using standard economic appraisal methodologies and by drawing on the Australia and New Zealand Property Council Guidelines for valuing contaminated land (2012), as well as US standards issued by the International Association of Assessing Officers (2001).

The key underpinning assumptions within the CBA's are detailed below.

Assumption	Value
Appraisal start year	2012
Price year	2012
Appraisal duration	30 years
Real discount rate after tax	7%
Remediation start year	2013

CBA models approximate the complex real world and consequently have limitations that affect the interpretation of results. Despite this, models examine complex issues logically and consistently across long timeframes. As with all modelling assessments, the modelling results require careful explanation. It is also sensible to undertake sensitivity analysis to evaluate the robustness of the key messages obtained from the modelling analysis.

To determine the robustness of the analysis, AECOM undertook a detailed sensitivity analysis. The key identified sensitivity is to stigma, which has been calculated based on the previous use for the East Lake site and the associated site contamination.

A second set of sensitivity analysis was undertaken on the potential impact of changes in the adjustment rate from the LDA land values, which are predominantly from property released in outer suburbs, to the potential land values of the East Lake site given its proximity to key services.

The key findings of the CBA are:

- All of the options appear to provide a positive Net Present Value (NPV), with the probabilistic analysis suggesting that 95% of the NPVs will be positive. This is in part due to the high land values of the area containing East Lake.
- The potential for cost overruns in options 1 to 3 pose the largest risks to a positive NPV being generated from remediation.
- Stigma has the potential to materially impact land values. The analysis has shown that this impact will be greatest for residential properties, and lower for commercial properties. This means that Option 4, with a larger proportion of commercial property, may be less affected by stigma.
- Option 4 and Option 3 have essentially the same P50 NPV. However the range of NPVs for option 4 is narrower than for option 3, meaning that it is less risky.
- This analysis should not be read as a definitive assessment of each option's financial viability. Other issues that are currently unquantifiable, such as possible contingent legal liability, could have significant implications for the ranking of options.

Based on the information presented within previous environmental investigations, the information available relating to current site conditions and the calculated cost associated with site remediation (based on 2012/2013 cost estimates) it is the opinion of AECOM that "Option 4" should be considered as a feasible methodology of remediating the site in preparation for subsequent Site sale development.

1.0 Introduction

AECOM Australia Pty Ltd (AECOM) was engaged by Environment and Sustainable Development Directorate (ESDD) to prepare a Site Preparation Feasibility Assessment for the site identified as the East Lake Urban Renewal Site (the Site).

The Site location and layout is detailed within **Figure F1**.

East Lake is identified in the *Canberra Spatial Plan* (2004) and the subsequent *ACT Planning Strategy* (2012), as an area for residential intensification due to its proximity to the central employment areas and major transport routes of Canberra, and its support of *The Canberra Plan 2003 Towards Our Second Century "A Sustainable Future"*. The area will also contribute to land release targets outlined for Canberra.

Previous studies for this precinct, including geotechnical, contamination, stormwater quality, flooding, transport, ecological and heritage investigations have indicated the need for supplementary studies to inform and facilitate the consideration of development proposals for East Lake and the required variation to the Territory Plan. Part of the outcomes of previous investigations was the discovery of unsuitable ground materials (uncontrolled fill) and contaminated areas within the East Lake precinct.

These materials were determined to potentially have significant implications on development costs due to the site remediation and preliminary earthworks tasks required to respond to such constraints. If, for example, unsuitable fill material is simply disposed off-site, the financial cost to the ACT Government (land fill, trucking, etc) could render the project unfeasible.

The development and assessment of various Site preparation scenarios that examine a range of management strategies is critical to the success of the development. These strategies should consider maximising the onsite re-use of fill materials identified as having a range of geotechnical and contaminant constraints.

As a result, further investigation of potential site preparation scenarios was required to determine feasibility of proposed site preparation options for both geotechnically unsuitable and contaminated fill materials.

1.1 Vision for East Lake

The Griffin Legacy and sustainability showcase

The East Lake site is primed for urban revitalisation and contains all the ingredients necessary to showcase the ACT Government's progressive attitude towards sustainable development and innovation.

The project's success has been identified as the culmination of social, economic and environmental sustainability in creating one of the ACT's premier development sites.

The success of this project is directly linked to several key strategies being adopted by ESDD including:

- Maintaining the economic vitality of development within the ACT
- The strength of urban design and leadership
- The input and uptake of community stakeholders.

Located within 3 km of the seat of Australia's political power, it is ideally located to exhibit the progressive thinking of the ACT while continuing the "Griffin Legacy" into the 21st century and beyond.

Leaving the industrial and commercial past behind, East Lake Urban Renewal program, , has the potential to become a benchmark for urban development in Australia through the sustainable development of high quality residential developments within a previously contaminated site.

The adjoining Jerrabomberra Wetlands are of particular significance for the ACT, the south-east highlands region and nationally. This importance has been clearly documented during the development of master plans for the Jerrabomberra Wetlands Nature Reserve.

Careful management of stormwater and adoption of Water Sensitive Urban Design (WSUD) practices within East Lake have the potential to form the backbone of an ecologically sensitive and practical integration of the two sites, and contribute to protecting the highly significant Jerrabomberra Wetlands. The approach and philosophy to designing the interface between the two areas will be critical to achieving this outcome.

In 2010, CSIRO identified principles for the interface to be adequately considered. More recent work undertaken as part of the ongoing master planning for the Jerrabomberra Wetlands Nature Reserve progressed the investigation into possible solutions for the integration of WSUD into the urban area as well as within suitable locations in the Reserve.

This project will need to build further on the work completed to date on the management of the interface between the urban renewal area and the Jerrabomberra Wetlands.

A landmark urban development project for the ACT

East Lake is located within close proximity to the Canberra Civic area and the Parliamentary Triangle and has been identified to form part of the residential intensification of inner Canberra under the Canberra Spatial Plan and subsequent 2012 ACT Planning Strategy. A wetland of significance (Jerrabomberra Wetlands Nature Reserve), transport facilities (Monaro Highway, Canberra Railway Station), iconic and highly valued retail and commercial areas (Kingston, Manuka, Fyshwick Fresh Food Market), and Lake Burley Griffin form the positive and attractive context for the site.

East Lake Urban Renewal has strong potential to develop into a land mark project in the ACT. An urban planning response combining the right mix of residential and commercial land uses in a positive urban form may maximise the location, amenities and attractiveness of the site. This urban development project is markedly different from any other development project in the ACT and the wider region.

A vibrant contribution to the water edge of Lake Burley Griffin

Lake Burley Griffin is treasured by a significant proportion of Canberrans. A stroll along the edge of the lake on the week-end readily reveals that people appreciate the amenities offered by the lake, including:

- Iconic views
- Relaxing and enjoyable experiences
- Recreational and sporting opportunities
- A safe environment
- Social interaction, and
- A network of continuous uninterrupted pedestrian and cycling paths.

The shores of Lake Burley Griffin are now almost fully allocated with a combination of national buildings, parks and reserves, the National Arboretum, the Australian National Botanic Gardens, the Kingston Foreshore Development and the higher density area of Civic.

East Lake is one of the ACT Government's final opportunities to add a vibrant and attractive contribution to the experience of the Lake. At present, most uses of the lake are to the west, a successful project at East Lake has the potential to reactivate the East Basin enabling both visitors and residents of the ACT to enjoy the full extent of the lake. Success will require addressing and responding in a positive way to the past uses of mixed industrial and commercial (e.g. rail yards).

A key site as part of the ACT Land Release Programs

The *ACT Indicative Residential Land Release Programs for 2012-2013 and 2015-2016* are an important keystone in the ACT Government budget and financial planning. Given the nature of the economy in the Territory, the land release program is key to generating the Government revenues that can be used to finance the Government programs and projects.

East Lake has been identified in the current ACT Land Release Program, with an initial release of 100 dwellings on 2015-2016.

1.2 The Challenges

Meeting Sustainable and Economic Objectives

As outlined above, the East Lake site is unique in the ACT and the region. The residential and commercial products that would be made available have a special potential for attracting buyers and occupants. The returns for the ACT Government, if the full land value is realised, are potentially high.

In order to achieve the full land value, a number of challenges will have to be overcome. In particular, the development of management strategies for maximising the onsite re-use of fill materials identified as having a range of geotechnical and contaminant constraints.

Previous environmental investigations undertaken within the site identified a range of contaminants (in limited concentrations) throughout a matrix of currently unsuitable fill materials for use within the proposed development. If unsuitable fill material is simply disposed off-site, the financial cost to the ACT Government (land fill, trucking, etc.) could render the project financially nonviable.

To enable the development to proceed and meet ACT Government land release targets, while maximising both its environmental and economic sustainability, solutions must be developed to maximise the beneficial re-use of onsite fill materials.

A range of options for the re-use of fill materials is to be examined to ensure that the most cost effective and sustainable solution is developed. AECOM understands that any developed solution must be in keeping with the overarching philosophy for East Lake and not negatively affect public opinion of the site or significantly reduce the area of land available for future development.

A site with particular public scrutiny

These technical issues are not unique to East Lake. The nearby Kingston Foreshore development has experienced similar challenges associated with contamination issues similar to those identified within East Lake.

The development within Kingston Foreshore has highlighted the importance of transparent, consistent and scientifically defensible management of these issues to the success and overall public opinion of a development site. It will also be imperative to develop effective and accountable governance arrangements that assist in the management of these issues.

Public opinion and reputation for the project will be central to realising the full land value for the site. The development of site development options that incorporate sustainable project outcomes, innovative and smart solutions to modern urban issues, and technical credentials in geotechnics, remediation, WSUD and urban planning will support achieving confidence in the public opinion.

1.3 Project Objectives and Scope

The primary objective of this report is to assess the logistics and evaluate the feasibility of various site preparation options for contaminated and geotechnically unsuitable fill materials previously identified at the Site while considering remediation objectives, technical practicability, and logistical constraints.

To meet the project objective, AECOM undertook the following scope of work:

- Detailed desktop review of data collected during previous investigations at the Site
- Reviewed concurrent studies being undertaken within the Site
- Commissioned Leach Steger Pty Ltd to complete a site survey to determine current site specific levels
- Assessed approximate fill volumes based on the results of the site survey and the existing subsurface information
- Reviewed site constraints and options in the context of the proposed development including
 - Geotechnical Options
 - Geotechnical Design
 - Contamination Management Options
 - Imported Fill Material Options

- Stormwater and Flooding Management Options
- Water Sensitive Urban Design Options
- Civil Infrastructure Assessment
- Assessed the practicality and feasibility of three previously determined Site remediation options;
 - Option 1 – Clean environmental hotspots, cap uncompacted fill area as required. Management of general geotechnical and environmental issues would be managed by individual Site developers
 - Option 2 – Remediate the whole of the fill for geotechnical and environmental contamination by excavation, removal of unsuitable materials and replacement of the soil materials as controlled fill
 - Option 3 – Clean environmental hotspots and use partial excavation in conjunction with ground improvement such as impact rolling to improve the geotechnical properties of the site followed by adequate controlled fill capping.
- Developed a 4th Site remediation option based on the outcomes of works undertaken as part of this assessment
 - Option 4 – Other options that become evident during detailed assessment of the interaction between the development staging, environmental and geotechnical requirements
- Calculation of an 'opinion of cost' for each potential remediation option for incorporation into the subsequent cost benefit analysis;
- Development of a detailed staging plan for Site preparation works; and
- Development of a detailed Cost Benefit Analysis of each of the four remediation options in relation to the Draft Planning and Design Framework.

2.0 East Lake Urban Renewal Project Site

SECTION SUMMARY

- This section details the location and surrounding land uses of the East Lake Urban Renewal Project Site and reviews details of past and current land uses to provide context to the subsequent sections of the report
- The physical characteristics of the Site described within this section are crucial for an understanding of the Site specific conditions to be considered during evaluation of site preparation options and subsequently managed during site preparation works
- Details of the original Planning and Design Framework presented within this section outline the “Vision for East Lake” in terms of urban renewal and land use mix planning, and indicate the proposed development will consist of the following key components:
 - Residential housing including low and mid-rise apartments, compact housing and mews housing;
 - Recreational open space including parkland, public gardens, walking trails and cycle ways;
 - Public space possibly including preschool, primary, secondary and tertiary educational facilities, community centres and sports playing fields;
 - Commercial units;
 - “Clean” industrial units; and
 - General infrastructure including improvements to road, rail and utility services.

2.1 Previous Investigations

Previous investigations undertaken with the Site upon which the desktop review is based are detailed below:

- Phase 1, Environmental Site Assessment, East Lake Urban Renewal Project Fyshwick ACT 2005, Coffey Geosciences Pty Ltd
- East Lake Urban Renewal Draft Planning Report, ACT Planning and Land Authority, September 2007
- Phase 1, Environmental Site Assessment, East Lake Urban Renewal Project Fyshwick ACT March 2010, Parsons Brinckerhoff (PB)
- East Lake Geotechnical Site Assessment, Parsons Brinckerhoff for ESDD, June 2010 (digital) (PB 2010a)
- East Lake Sampling, Analysis and Quality Plan (SAQP), Parsons Brinckerhoff for ESDD, September 2010 (PB 2010b)
- East Lake Development Short Term Environmental Management Plan, Parsons Brinckerhoff for ESDD, December 2010 (PB 2010c)
- East Lake Remedial Action Plan, Parsons Brinckerhoff for ESDD, March 2011
- Site Audit Report, Proposed East Lake Development, WSP for ESDD, July 2011
- Revised Draft East Lake Planning And Design Framework Draft Report General Layout, Rod Simpson for ESDD 2012
- Strategic Review of the East Lake Remedial Action Plan and Material Management Measures, WSP for ESDD, July 2011

2.2 Site Location and Surrounding Land uses

Approximately 471 ha in size, the proposed East Lake precinct is located within the south-eastern Canberra suburbs of Kingston and Fyshwick.

The precinct includes the Jerrabomberra Wetlands Nature Reserve comprising approximately 221 ha, the remainder of the site which has been previously developed (approximately 250 ha) is comprised of a mix of industrial and commercial land uses with some low density residential within the north western portion of the Site (see Figure 1).

The site identification and land use details are summarised in Table 1 below.

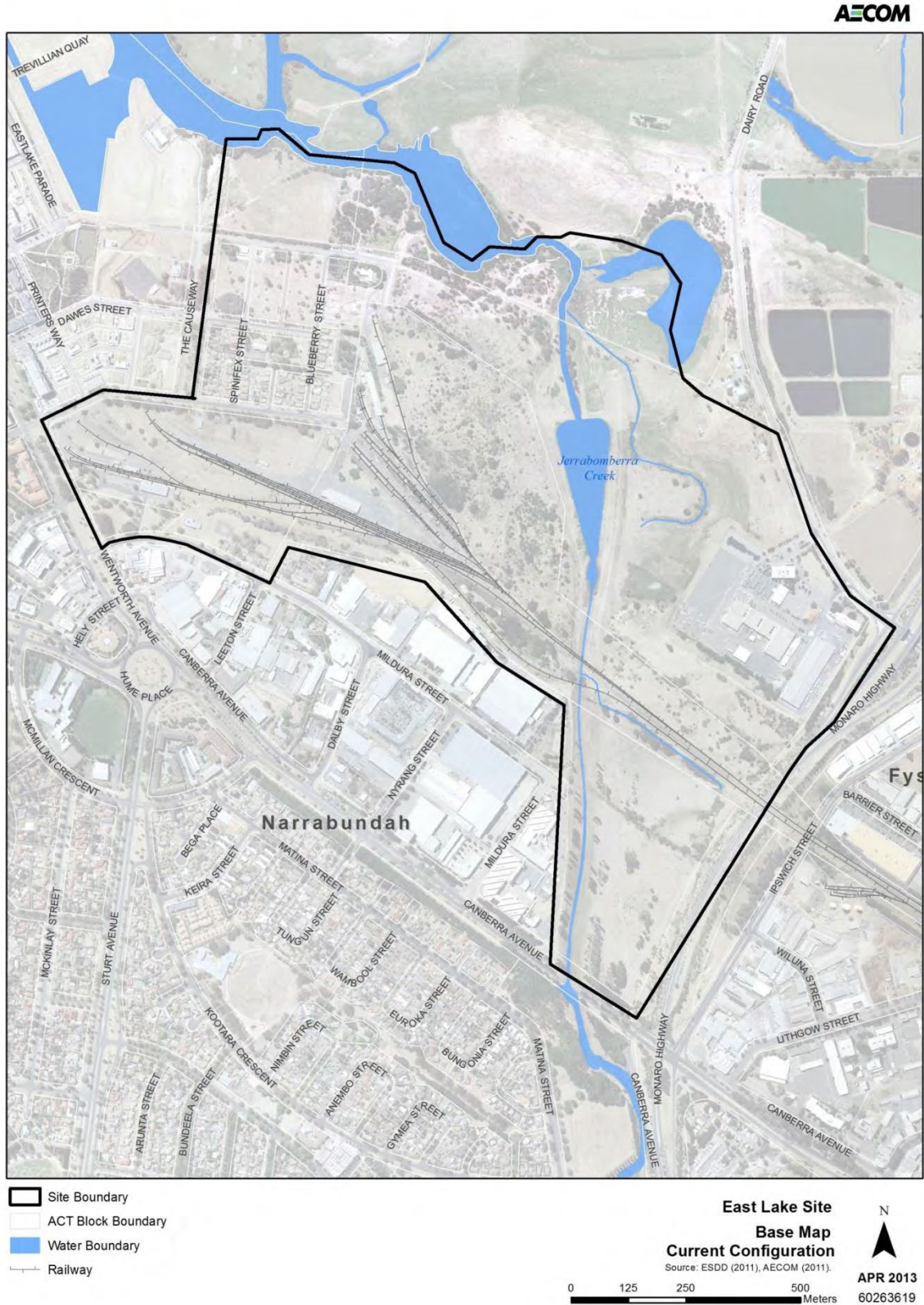
Table 1 Site Identification Details

ITEM	DESCRIPTION
Site Identification	East Lake precinct
Site Address	Proposed East Lake Development within the south-eastern Canberra suburbs of Griffith, Kingston and Fyshwick, ACT
Site Size	Approximately 471 hectares
Local Government Area	ACT
Current Property Description and Land use	<ul style="list-style-type: none"> - Block 7 Section 11 Kingston (excluding Canberra Railway Station, the rail corridor and Coinda Court) - Block 2 Section 39 Kingston - Block 3 Section 39 Kingston - Block 4 Section 11 Kingston - Block 10 Section 47 Kingston - Block 11 Section 47 (includes municipal landfill) - Block 14 Section 38 (includes municipal landfill and is adjacent to the Wetlands Foreshore Business Park - former DAS fleet refuelling facility) - Block 20 Section 6 Kingston (includes "Causeway tips") - Block 1 Section 74 Fyshwick (south of Jerrabomberra Creek includes "Causeway tips") - Part Block 2 Section 66 Fyshwick - Block 8 Section 30 Fyshwick
Proposed Land Use (post-remediation)	Mixed use comprising residential, open space and commercial/industrial
Current Zoning	Various: TSZ2 – Services (transport and services), IZ1 – General Industrial, RZ1 – Suburban (residential), PRZ1 – Urban Open Space; and Central National Area – Lake Burley Griffin and Foreshores (National Capital Plan)
Site Location	refer Figure 2

East Lake is located in a mixed use area comprising railway operations (including refuelling facilities), public open space and commercial buildings (primarily warehousing and distribution centres). Surrounding land uses include the following:

- **North** – Jerrabomberra Wetlands Nature Reserve
- **East** – Wetlands Foreshore Business Park, and Fyshwick industrial area
- **South** – Commercial/Industrial area, with low density residential land beyond
- **West** – Kingston Foreshore Development

Figure 1 East Lake Urban Renewal Project



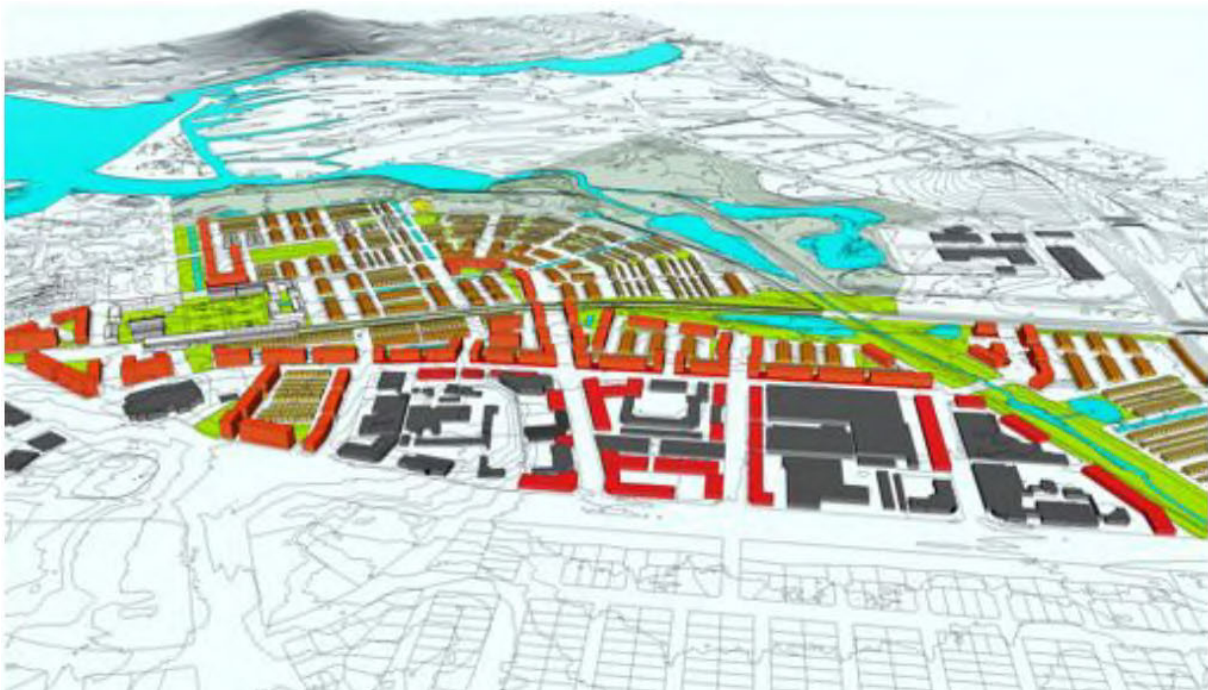
2.3 Proposed Redevelopment

The 2004 Canberra Spatial Plan, the subsequent Act Planning Strategy (2012) and the revised 2011 Draft Planning and Design Framework (Simpson and Wilson 2011) identifies East Lake as a potential area for urban renewal (Figure 2).

It is the understanding of AECOM that the proposed development will consist of the following key components:

- Residential housing including low and mid-rise apartments, compact housing and mews housing;
- Recreational open space including parkland, public gardens, walking trails and cycle ways;
- Public space including preschool, primary, secondary and tertiary educational facilities, community centres and sports playing fields;
- Commercial units;
- 'Clean' industrial units; and
- General infrastructure including improvements to road, rail and utility services.

Figure 2 Project Concept (Source Simpson and Wilson 2011)



2.4 Site History

A review of aerial photography presented within previous investigations indicates the history of the Site and surrounding area as follows:

1944

In 1944 the Site was mostly undeveloped or possibly used for grazing, with a train line running through the area. In addition to undeveloped or agricultural land, land uses included some residential development to the west of the Site.

Figure 3 Historical Aerial Photograph – 1944



1961

By 1961, a dairy farm was established along Dairy Road, and by 1968 the majority of the site was cleared, with the exception of areas along the creek. Commercial development is progressing to the south-west and east of the site, urbanisation is increased to the west, and large water ponds have been established to the east of Dairy Road.

Figure 4 Historical Aerial Photograph – 1961



1968

By 1968 Jerrabomberra Creek has been straightened and partly channelled. The central area of the Site as well as the area along the northern site boundary has been extensively filled, and fill has been deposited along the eastern site boundary. By this time Lake Burley Griffin has filled and the railway station and refuelling facility have also been constructed. Further commercial development has also occurred.

Figure 5 Historical Aerial Photograph --1968



1985

By 1985 the north-eastern corner of the Site has become a wetland. The central landfill is predominantly grassed and additional areas have been filled, and urbanisation further increased. All buildings currently present have been built.

Figure 6 Historical Aerial Photograph -- 1985



1998

By 1998 no significant changes to the Site or surround land uses occurred, however there was extensive vegetation growth across the Site.

Figure 7 Historical Aerial Photograph ---1998



2.5 Current Land Uses

At the time of this report, the Site is mostly undeveloped and covered with grass, shrub and tree species

Information provided within PB (2011) indicated the Site to be traversed by:

- Jerrabomberra Creek, which meanders between the Site's south-eastern and north-western corners. From the south-east corner, the creek runs straight for approximately 600 m towards the north (in this area, it has been channelled, and is surrounded by tall grasses and reeds). The channel eventually discharges into a triangular 'silt trap' oriented north-south, approximately 300 m long and 100 m wide. From this silt trap, the creek follows its original meandering path, in a general westerly direction and discharges into Lake Burley Griffin in the Site's north-western corner.
- The Canberra Railway line, entering the Site in its east, and terminating at Canberra Train Station in the western part of the Site. A corridor around this railway line has been excluded from the investigation area. A few buildings are located on the northern side of this railway line, in the Site's western part. In the centre of the site, the rail line branches to the north-west, terminating at a railway museum and then at a company with railway related activity.
- Fill has been deposited in large parts of the Site, particularly the central area.
- No Underground Storage Tanks were noted on site.

2.6 Topography

Information provided within PB (2011) indicates the Site is mostly flat with slight undulations over the open areas comprising landfills around Jerrabomberra Creek.

The topographical map indicates the site elevation ranges between 560 to 570 m AHD. The site generally slopes towards Jerrabomberra Creek.

Topographical information obtained during the Site survey is presented within Section 3.1.

2.7 Regional Meteorology

Climatic data was obtained from the Bureau of Meteorology (BOM) website (www.bom.gov.au). The BOM weather station (070014), located at Canberra Airport indicates the following:

- Average annual rainfall of 616 mm, with October and November typically being the wetter months (>60 mm per month)
- Average maximum temperature of 19.7°C, ranging from 28.0°C in January to 11.3°C in July
- Average minimum temperature of 6.5°C, ranging from 13.2°C in January to 0.1°C in July.

2.8 Local and Regional Hydrology

There is no documented or apparent permanent surface water body on the Site. There are however a number of significant water bodies in close proximity.

The closest surface water body to the Site is the Jerrabomberra Wetlands located on the northern boundary of the Site. The East Basin of Lake Burley Griffin is situated approximately 250 m to north-west of the Site.

In terms of gazetted waterways, the Site is bounded by the final reaches of Jerrabomberra Creek to the east, and the so-called Jerrabomberra Reach in the north. The following recent flood studies have been undertaken for the Molonglo River and Jerrabomberra Creek:

- Molonglo Catchment and Scrivener Dam Flood Hydrology Review – Phase 2, Hydraulics and Inundation Mapping Report (SKM, June 2011)
- East Lake Pond and Lake at Symonston Feasibility Study – Options and Concept Design Report (Cardno, January 2012).

The existing flood studies identify that some areas of the Site will be inundated during the 100 year ARI Molonglo River and/or Jerrabomberra Creek flood events. The potential for flooding across the Site under normal rainfall conditions is considered to be low, based on the Site elevation, local drainage and hydrogeological conditions.

2.9 Geology

The 1:100,000 Geology Sheet of Central Canberra, published by Bureau of Mineral Resources (BMR) (GA Henderson, 1985) and the Canberra, Queanbeyan and Environs 1:50,000 geology sheet (GA Henderson, 1980) indicates the Site is underlain by sedimentary bedrock of the Canberra Formation, comprising sandstones, shales and siltstones overlain by alluvial and colluvial deposits from the Quaternary and Tertiary geological periods (PB 2011).

The 1:10,000 map records the presence of a landfill in the area of the railway site (Block 2, Section 47, Fyshwick).

2.10 Soils

The Phase 2 Environmental Site Investigation (PB 2010) undertaken within the Site identified six key areas of fill material within the Site.

A significant quantity of fill was encountered within the central landfill, the two smaller landfills immediately south of Jerrabomberra Creek and the landfills north-west and south of the former DAS Fleet site.

The fill thickness was recorded to a depth of 6m within the central landfill. The fill composition was found to be highly variable and often discoloured, from sandy silt clay to silty clay, red to grey-brown with plastic, wood, metal, glass, steel mesh, bricks, rubber, tyres, concrete, newspaper, batteries, fibrous cement sheeting (including asbestos), scrap metal, paint tins, ash and coal. Boulders were also encountered at some locations. All fill has to be treated as geotechnically 'uncontrolled fill'.

Fill was not encountered within the bird-watching area along Jerrabomberra Creek.

Fill material was noted to be underlain by natural materials including silt, clayey silt, silty clay, sandy clay and sandy gravel. Siltstone and sandstone rock were encountered within the depth of borehole drilling at two locations.

2.11 Acid Sulphate Soils

The Acid Sulphate Soil Risk Map from CSIRO Australian Soil Resource Information System reviewed as part of PB (2011) indicated an extremely low probability of Acid Sulphate Soils (ASS) occurring at the Site.

2.12 Hydrogeology

Information provided within PB (2011) indicated groundwater levels within the wetlands are approximately 2 m below ground level (BGL).

During the PB 2010 contamination investigation (PB 2010b), it was found that groundwater flows generally towards Lake Burley Griffin with local variations in the vicinity of Molonglo River and Jerrabomberra Creek. Groundwater conditions are expected to be strongly influenced by the nearby Jerrabomberra Creek and adjacent wetland areas.

Previous investigations undertaken by PPK (summarised within PB 2010b) reported that groundwater levels in the vicinity of the railway vary seasonally from 2 m BGL to 10 m BGL, and generally lies between 4 m to 6 m BGL with dominant flows towards Jerrabomberra Creek. The 1:100,000 Hydrogeology map of the ACT and Environs (Evans and Moffat 1984) indicates that aquifers in the study area are likely to have:

- Yields generally of 0.5 L/s to about 1.0 L/s
- Concentrations of total dissolved solids expected to be less than 500 mg/L over the majority of the site and in the range of 500 mg/L to 1,000 mg/L in the south-eastern portion of the site, indicating fresh groundwater conditions.

During environmental assessment works undertaken by PB in January – March 2010, groundwater was encountered at depths ranging from 0.8–7.0 m below ground level.

Localised perched water tables are also expected to be encountered during remediation works.

2.13 East Lake Planning

ESDD engaged SGS Pty Ltd and Simpson + Wilson to develop the East Lake Urban Renewal Planning and Design Framework (PDF) in 2010 and revise the overall urban design of the East Lake urban renewal area in December 2011. The revised Planning and Design Framework was developed in response to four significant changes to the expected scope of the development:

- The impact of retaining the rail station in its current position and the reservation of a corridor extending to Wentworth Avenue as a possible future light rail or transit corridor;
- The need for a 500 m buffer from the sewage treatment works;
- The geotechnical conditions in areas of deep fill in large sections of the site that will require stabilisation and compaction to allow construction of even light weight structures including roads and pavements; and
- The need for a clearer stormwater strategy and the identification of flow paths through the Site.

Following a review of the above amendments and clarifications, Simpson and Wilson prepared the following revised draft PDF in December 2011.

Details of the proposed layout and location of various planned land uses are presented below within Figure 8.

Figure 8 Planning Design Framework (Source Simpson and Wilson 2011)



Based on the December 2011 revised draft PDF the following plan elements and development statistics (Table 2 and Table 3 respectively) were identified:

Table 2 December 2011 PDF Plan Elements (S+W 2011)

DEVELOPMENT	TYPE	sqm	Ha	%
Residential	Multi-unit Dwellings (footprint)	51,907	5.19	4%
	Mews	88,708	8.87	6%
Commercial	Terrace	156,728	15.67	11%
	Compact	44,899	4.49	3%
	Commercial (Footprint) SE Corner Industrial	25,387	2.54	2%
Open Space	Open Space	143,932	14.39	10%
	WSUD	-	-	
School	Creek Corridor	67,884	6.79	
	School	14,910	1.49	1%
Network	New Roads	374,413	37.44	27%
	Transit /rail	3,006	0.30	0%
	CIT	36,277	3.63	3%
Existing Area	Existing Industrial	300,412	30.04	21%
	Roads	64,430	6.44	5%
Total		1,399,112	139.91	100%

Table 3 December 2011 PDF Development Statistics (S+W 2011)

DWELLING TYPES	BEDROOMS	OCCUPANCY	NUMBER	APARTMENT MIX%	OVERALL MIX %	POPULATION
Apartment	1	1.5	346	15%	9%	520
Apartment	2	2.1	1,155	50%	28%	2,424
Apartment	3	2.6	577	25%	14%	1,501
Apartment	4	3	231	10%	6%	693
Subtotal			2,309		57%	5,138
Single lot mix%						
Terrace	3	2.6	307	18%	8%	798
Terrace + Studio	4 (incl. studio)	3	307	18%	8%	921
Compact House	3	2.6	73	4%	2%	189
Compact House	4	3	73	4%	2%	218
Mews House	2	2.6	495	28%	12%	1,287
Mews House	3	2.8	495	28%	12%	1,386
subtotal			1,749		43%	4,798
Total			4,058			9,936

3.0 East Lake Urban Renewal Existing Conditions

SECTION SUMMARY

- This section provides an overview of the existing site conditions identified as potential inputs into the development of subsequent site preparation options
- The information provided in this section was informed by previous investigations for the Site as detailed within Section 2.1
- The key site conditions outlined within this section relate to existing infrastructure, environmental and geotechnical conditions and storm water design
- The key site constraints to the proposed development were determined to relate to site contamination, geotechnically unsuitable fill materials and the storm water grading and levels required for development

3.1 Site Survey

Prior to the commencement of works AECOM commissioned a topographical survey within the 'Study Area' as defined within Parsons Brinckerhoff (2010) *East Lake Urban Renewal Project Fyshwick, ACT, Remediation Action Plan*.

The Site survey was undertaken to provide an accurate assessment of the Site's surface level to enable assessment of the in-situ fill volumes/locations, potential stormwater grading and minimum development level requirements for the proposed development.

The topographical survey included the following:

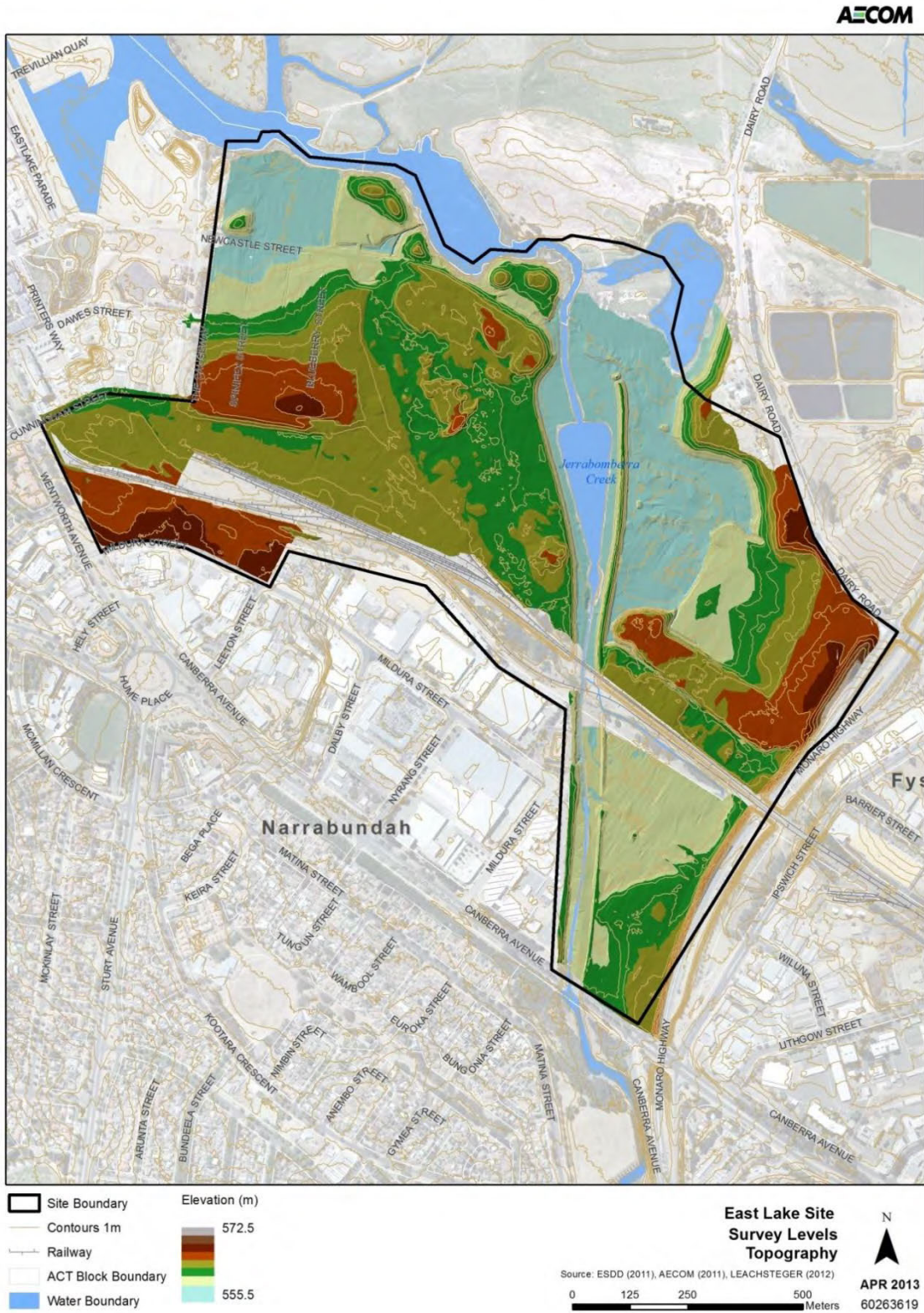
- Surface levels of natural ground and sealed areas (concreted/bitumised) using GPS RTK techniques (accuracy +/- 20--30 mm) at up to 50 metre grids. Significant changes in grade surveyed as break lines
- Limits of Site (ie. edge of water, back of kerb) surveyed using GPS techniques
- Roads (within road reserves) were surveyed at cross section intervals of up to 50m or at high/low points. Cross section features include levels at boundary line, gutter invert/edge bitumen and crown of road. Conventional (Total Station) survey techniques (accuracy +/- 5--10 mm) were used within residential (west) areas only
- Stormwater sumps/manholes and sewer manholes within road reserves, open space and easements – cover levels only. In addition, significant culvert invert levels and pipe sizes
- Contours generated at 0.5m intervals.

Once completed, AECOM imported all survey levels into GIS format, presented within Figure 9.

The Site survey indicated that the Site elevation ranges between approximately 555.5 m AHD within the east and west portions of the site and 572.5 m AHD within the north-west and south-eastern portion of the Site.

No significant topographical features were observed during the Site survey.

Figure 9 Current Surveyed Surface Level



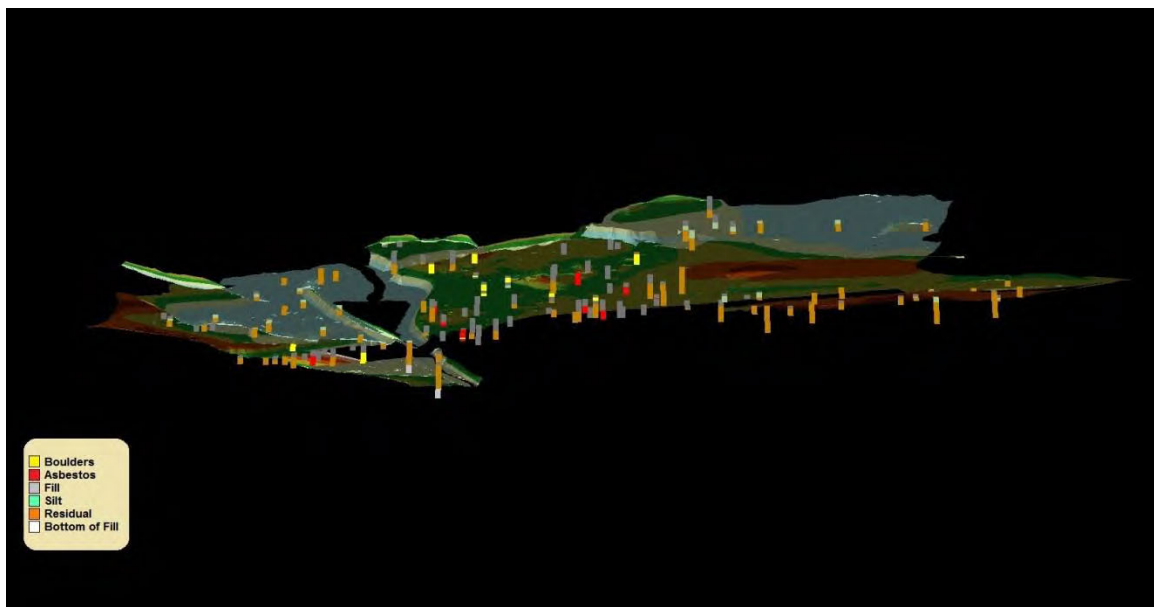
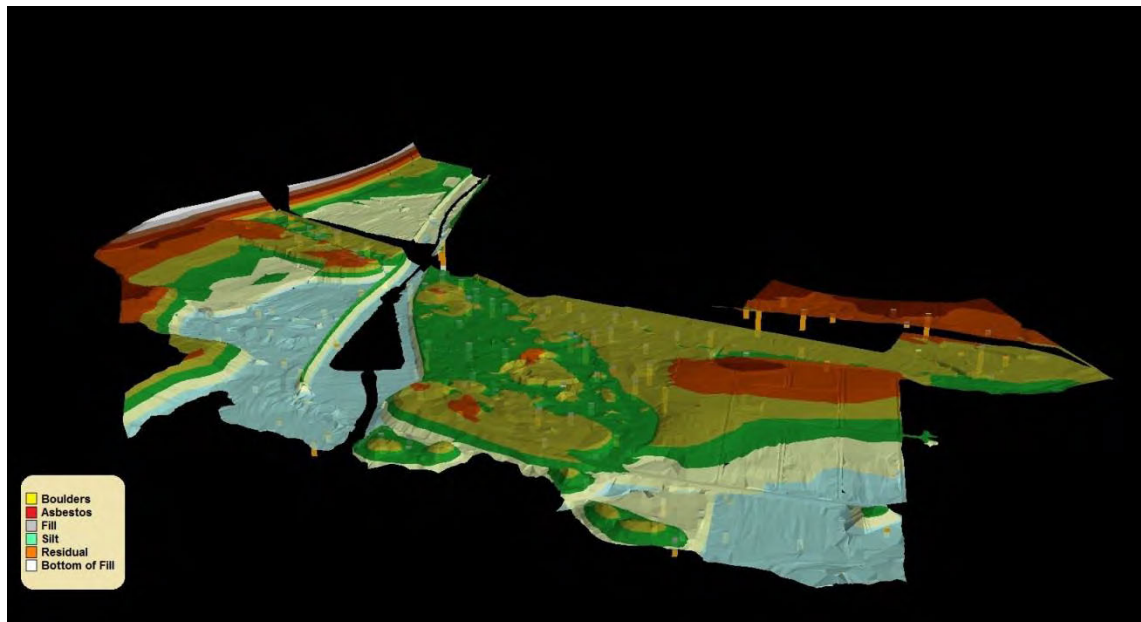
3.2 Revised Fill Volumes

Following completion of the Site survey, AECOM reviewed the total fill volumes reported by PB (2010).

- It should be noted that due to field methodologies undertaken within the PB Phase 2 ESA, several boreholes within fill locations were not excavated to the occurrence of natural material.
- It should also be noted that several discrepancies between the elevations recorded within the PB (2010) ESA and the 2012 site survey were noted. It is the opinion of AECOM that the discrepancies are due to errors in the initial 2010 site survey as a result of limited survey information.

AECOM undertook 3D modelling of the total volume of fill material within Site using the software program ArcScene (refer Figure 10 which also shows investigation locations). Where previously installed boreholes were not excavated to the occurrence of natural material, AECOM added a conservative correction factor of 1 m to the depth of fill at that location to ensure that subsequent costing's more closely reflecting the potential fill depths within the Site.

Figure 10 Fill Volume Modelling



Upon completion of fill modelling works, the revised total fill volume calculated within the Site was approximately 990,000m³.

3.3 Existing Infrastructure Assessment

A summary of the existing infrastructure assessment is provided below. It should be noted that anecdotal evidence provided by service providers indicates that existing infrastructure within the Causeway site may contain asbestos pipework that will require management and removal prior to upgrade or replacement works.

3.3.1 Road Asset Condition

A Road Asset Condition Assessment was conducted on 11 May 2012 by Fugro PMS in The Causeway. The assessment measured four key aspects of the pavement condition:

1. Surface defects;
2. Rut depths;
3. Surface roughness; and
4. Kerb and channel condition.

Rut depths and surface roughness were measured by scanning lasers while surface defects and kerb condition were obtained from digital video records. The results of the Road Asset Condition Assessment are shown in **Appendix B**.

The assessment provided the following findings:

- Approximately 20% of the pavement suffers from some form of significant surface defects (i.e. fatigue cracking, heavy patching and/or potholes);
- Approximately 76% of the pavement suffers from significant rutting (where more than 10% of the length has a rut depth greater than 5 mm);
- Approximately 20% of pavement within the study area has a NAASRA roughness count of 60 or higher, with approximately 80% of the pavement having a NAASRA roughness count over 100, indicating high road roughness; and
- Approximately 75% of the kerb and gutter within the study area was found to be in poor condition with a condition rating of 3-5.

The findings from the road asset condition assessment show that the majority of the existing road network in the Causeway area of East Lake is in generally poor condition. Significant upgrades and rehabilitation are required in order for the roads to be suitable for any future development and increased traffic loads.

3.3.2 Electricity

ActewAGL provided advice regarding the existing electricity infrastructure in East Lake and surrounding areas (Figure 11). The electricity supply to the East Lake area is currently provided from Telopea Park Zone substation in Kingston via The Causeway Switching Substation. The Causeway Switching Substation is connected to the Telopea Park Zone substation via three underground 132kV cables. The Telopea Park Zone substation currently provides service to a large area in the south of Canberra, and as such, is currently operating close to capacity. ActewAGL advised that the existing infrastructure may have some capacity to service some initial stages of the East Lake Development, but will not have sufficient capacity to cater for the entire development.

ActewAGL have planned to construct the new East Lake Zone substation to the east of the East Lake area. The substation is currently scheduled to be commissioned in late 2013. Once complete, the East Lake Zone substation will have sufficient capacity to manage the entire East Lake development as well as other new developments in the Eastern Broadacre area.

Once the yield of the final East Lake development scenario is provided and a more definitive staging plan is adopted, ActewAGL will be able to determine the interim strategy to service the proposed development prior to the East Lake Zone substation being commissioned.

3.3.3 Gas

ZNX was consulted regarding the existing gas infrastructure in East Lake and surrounding areas (Figure 12). ZNX provided preliminary advice detailing the condition and capacity of the existing gas network and any constraints which may affect future development in the area.

A number of existing medium pressure gas distribution mains currently service the existing properties in The Causeway. The distribution mains are fed via a secondary main on Cunningham Street connecting to the 200 mm, 1050 kPa secondary main running along Wentworth Avenue from the north. ZNX advised that the secondary and distribution mains in the area would have sufficient capacity to service development in the area.

Apart from the existing infrastructure in The Causeway, there is little gas supply infrastructure located in the East Lake development area. ZNX indicated that significant augmentations and extensions to the existing network would be required to service the entire East Lake development, in particular the areas to the east of The Causeway.

It should be noted that a high pressure gas transmission line is located on the eastern boundary of the Site adjacent to the Monaro Highway.

3.3.4 Sewer

ACTEW Water was consulted regarding the existing sewerage infrastructure in East Lake and surrounding areas (Figure 13). ACTEW Water provided advice detailing the condition and capacity of the existing sewerage network and constraints which may affect future development in the area.

The sewage and effluent from the existing properties in the East Lake area is pumped to the Fyshwick Sewage Treatment Plant (FSTP) via the Fyshwick Sewage Pumping Station (FSPS) and the Kingston Foreshore Sewage Pumping Station (KFSPS).

The KFSPS currently has spare capacity to service some development in the East Lake area. However, the full size of the East Lake development will likely result in the KFSPS being over capacity. The capacity will likely also be affected as the Kingston Foreshores development continues. At this stage, ACTEW Water has no current plans to upgrade the pumping station.

The FSPS is currently operating at capacity and would be unlikely to be able to service any additional loads produced by the East Lake development. ACTEW Water indicated that the emergency storage lagoon of the pumping station is scheduled to be upgraded to a dual purpose attenuation/emergency underground storage tank in 2017-2018 in order to be able to service the East Lake development and further growth in the catchment area. Any required augmentations prior to this upgrade would generally be provided in a reactive manner in response to any development that would affect the capacity of the lagoons, rather than as a pre-emptive measure.

In 2011, ACTEW Corporation conducted a strategic study on the Fyshwick Sewerage Treatment Plant as part of the Canberra Sewerage Strategy 2010-2060. The study recommended that if the treatment plant underwent regular minor upgrades, the plant would be able to meet the future growth in the area and remain in operation until around 2030. After this time major upgrades to the treatment plant and sewerage network would be required. Thus it is expected that the FSTP will be able to sufficiently cater for the additional sewer loads produced by the East Lake development.

The existing sewerage main network within the East Lake area is currently in generally good condition with additional capacity available to service initial parts of the East Lake development. However, as much of the East Lake area is likely to be re-graded as part of the development, many of the existing sewer mains may require replacement in order to carry the additional flows produced by the development. The existing rising mains carrying the flows from the two pumping stations to the FSTP may also require augmentation in order to carry the additional loads.

3.3.5 Stormwater

TaMS piped stormwater infrastructure is primarily located in The Causeway and along the extent of the railway infrastructure. The existing stormwater network within The Causeway generally drains in a northerly direction and the existing stormwater network surrounding the train station drains towards Kingston (Figure 14).

The existing urban area located between the railway line and Canberra Avenue comprises existing stormwater networks that drain in a northerly direction before discharging to Jerrabomberra Creek via a network of floodways and swales adjacent the railway line embankment. All stormwater from the East Lake site flows uncontrolled and unmanaged to the outlets.

Stormwater Infrastructure – Minor System

Preliminary calculations indicate that the existing stormwater infrastructure within The Causeway has inadequate capacity to convey the minor (5 year ARI) storm event in accordance with the TaMS Design Standards for Urban Infrastructure (DSUI). If any sections of the existing stormwater network are intended to be retained then it is recommended that a detailed assessment of the existing stormwater network capacity be undertaken. The vast majority of the existing stormwater infrastructure will need to be abandoned whilst re-grading the Site.

Stormwater Infrastructure – Major System

The East Lake site and surrounding catchment does not currently have any formal major stormwater drainage infrastructure. Currently, gap flows (flows in excess of the piped (minor) network capacity) are conveyed as overland flow along the existing road carriageways and road network.

Major storm event drainage infrastructure is designed to carry the gap flow or difference between the piped minor flow and the major (100 year ARI) flow, as well as providing freeboard to abutting developments. Major infrastructure typically includes channels and floodways, cut-off drains or overland flow on the road (maintaining one carriage way for safe vehicle movement). Major infrastructure is often required to provide freeboard, which is the difference between the top of bank and the peak water level. The minimum permissible freeboard for floodways is 300 mm (TaMS DSUI), while the recommended freeboard is 500 mm (Australian Rainfall and Runoff).

When designing major infrastructure, several factors need to be taken into account – some of which include vegetation (landscaping, trees, etc.) located within the 100 year ARI flood inundation extent, stormwater velocities, hydraulic profiles, etc.

Detailed investigation is required in order to determine upgrade requirements in order for the Site to meet the requirements of servicing the flow produced by the major (100 year ARI) storm.

Stormwater Quality Management and WSUD

There are no existing stormwater quality control measures in the catchment or in the Site area. Urban stormwater is discharged uncontrolled to Jerrabomberra Creek.

The catchment is not expected to be able to meet the current stormwater quality improvement targets as specified in the ACT WaterWays Water Sensitive Urban Design General Code.

3.3.6 Telecommunications

Discussions were held with various telecommunications providers in order to investigate the capacity of existing networks in the area and extension requirements in order to service the new development .

AAPT

There is no existing AAPT infrastructure in the East Lake project area.

AAPT is able to expand its existing network into the East Lake area if the need arises from infrastructure located either side of the project area. It is expected that the East Lake development would stimulate customer demand that would be of interest to AAPT.

ICON

There is currently extensive ICON infrastructure in the eastern section of the East Lake site along Monaro Highway as well as to the south of the Site along the northern verge of Canberra Avenue. The infrastructure in both of these areas are part of a Major Trunk Network which services much of the south of Canberra. Any works near these areas would require consultation with ICON prior to design and construction to ensure no ICON infrastructure is compromised.

ICON has indicated that they would be interested in extending their current network along Wentworth Avenue to the west, and if an opportunity arose to work in conjunction with other developments in the area, they would be open to discussion. Any upgrades/extension to the network would primarily depend on the type of development that required communications services. ICON specified that at this stage, services would not be provided to residential developments. Connections to commercial and office developments may be looked at depending on the intended use of the property, however, service would generally only be provided if a property housed a government organisation.

Nextgen

There is currently no Nextgen infrastructure servicing properties within the East Lake project area. If a need for service arose within the area, Nextgen would be well positioned to provide access to its network at a relatively short notice from the adjacent cabling.

Nextgen expects that there will not be much requirement for servicing the area, as Nextgen primarily provides high end data service to corporate and government customers, and the proposed development is largely residential.

Optus

There is currently no Optus infrastructure within the East Lake site, however, there is major Optus infrastructure running along Wentworth Avenue and Canberra Avenue adjacent to the project area. Due to this fact, Optus is well placed to provide service to the area. Optus will consider each service request on a case by case basis and will generally only provide services when the need arises.

Telstra

Telstra indicated that there is sufficient capacity within the existing network in the surrounding area to service the project area. However, some major extensions would be required from the existing network on Canberra Avenue and Wentworth Avenue to within the project area.

Telstra will be able to provide further comments on the facilities to provide service to the Site once a more detailed plan is available.

TransACT

There is extensive existing TransACT infrastructure within the East Lake area. TransACT have a major exchange located opposite The Causeway which currently services a large surrounding area in the south of Canberra. In order to service the proposed East Lake development, TransACT would require additional cabling to be provided within the project area to individual properties. TransACT indicated that they would generally only provide services on a supply and demand basis.

NBN

There is no NBN infrastructure currently located within the project area.

3.3.7 Water

ACTEW Water was consulted regarding the existing water supply infrastructure in East Lake and surrounding areas. ACTEW Water provided advice detailing the condition and capacity of the existing water supply network and constraints which may affect future development in the area (Figure 15).

The East Lake area falls on the edge of the South Canberra water supply pressure zone. Water supply to East Lake and the surrounding areas is currently supplied by the Narrabundah, Red Hill and Deakin reservoirs to the south. The reservoirs supplying the East Lake area have limited capacity, with significant augmentation likely to be required in order to service any large scale development such as the ultimate East Lake development scenario. These reservoirs will also be required to service additional developments in the Eastern Broadacre area. ACTEW Water will be preparing more definitive strategic plans to service these developments in the next one to two years.

ACTEW Water indicated that the bulk supply mains carrying water from the reservoirs to the South Canberra Pressure zone will likely not have sufficient capacity to service additional demands such as those required by the East Lake development. Additional bulk supply main(s) into the pressure zone may be required in the early stages of development.

Water is presently supplied to The Causeway from a 300 mm diameter distribution main running along Wentworth Avenue. An additional water supply main to The Causeway is provided by a 150 mm reticulation main from Mildura Street to the south.

The existing water infrastructure in The Causeway consists of a number of 100 mm, 150 mm and 225 mm diameter reticulation mains servicing the existing properties. ACTEW Water advised that the 100 mm diameter reticulation mains would not meet the required fire demand requirements, and would necessitate replacement with larger capacity mains if any development were to occur in the area.

Limited water infrastructure exists in the areas outside of The Causeway. Significant extensions to the existing network are required to service new parts of the development in these areas. Discussions with ACTEW Water

concluded that although the existing water supply network has some capacity to service initial developments in the area, significant augmentations are required in order to meet the ultimate demands of any development scenario.

Figure 11 East Lake Utilities Investigation – Electricity

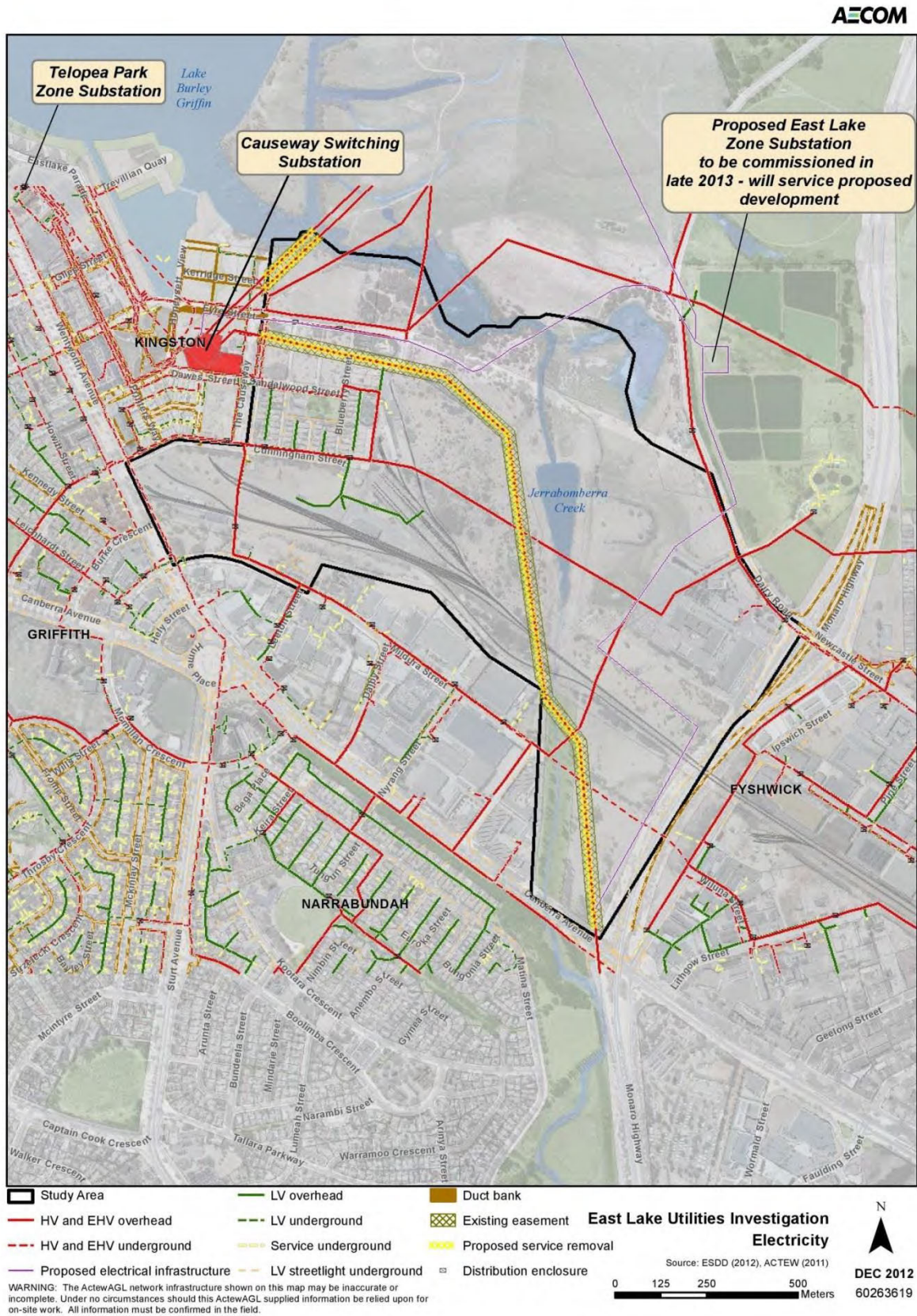


Figure 12 East Lake Utilities Investigation – Gas

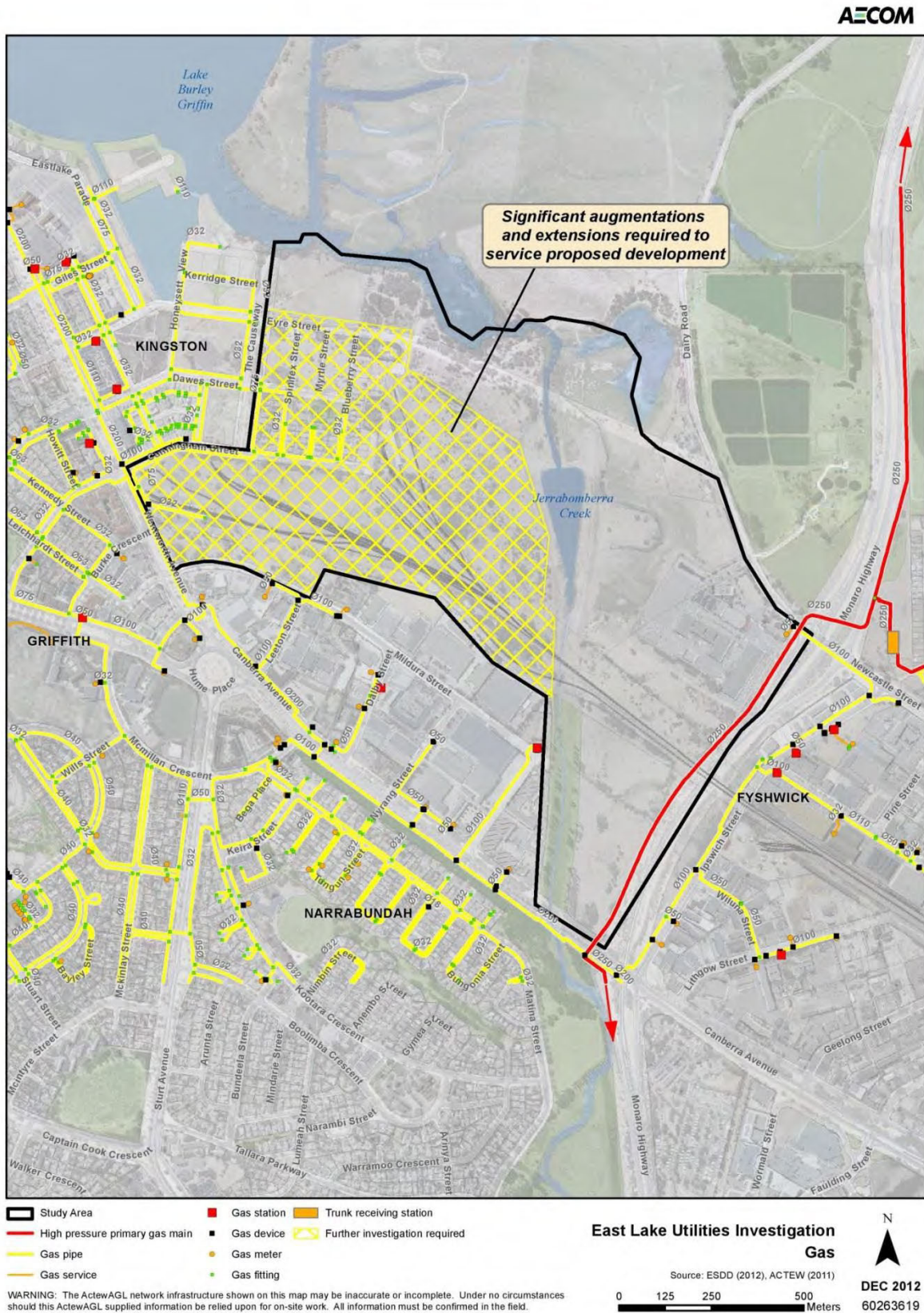


Figure 13 East Lake Utilities Investigation – Sewer

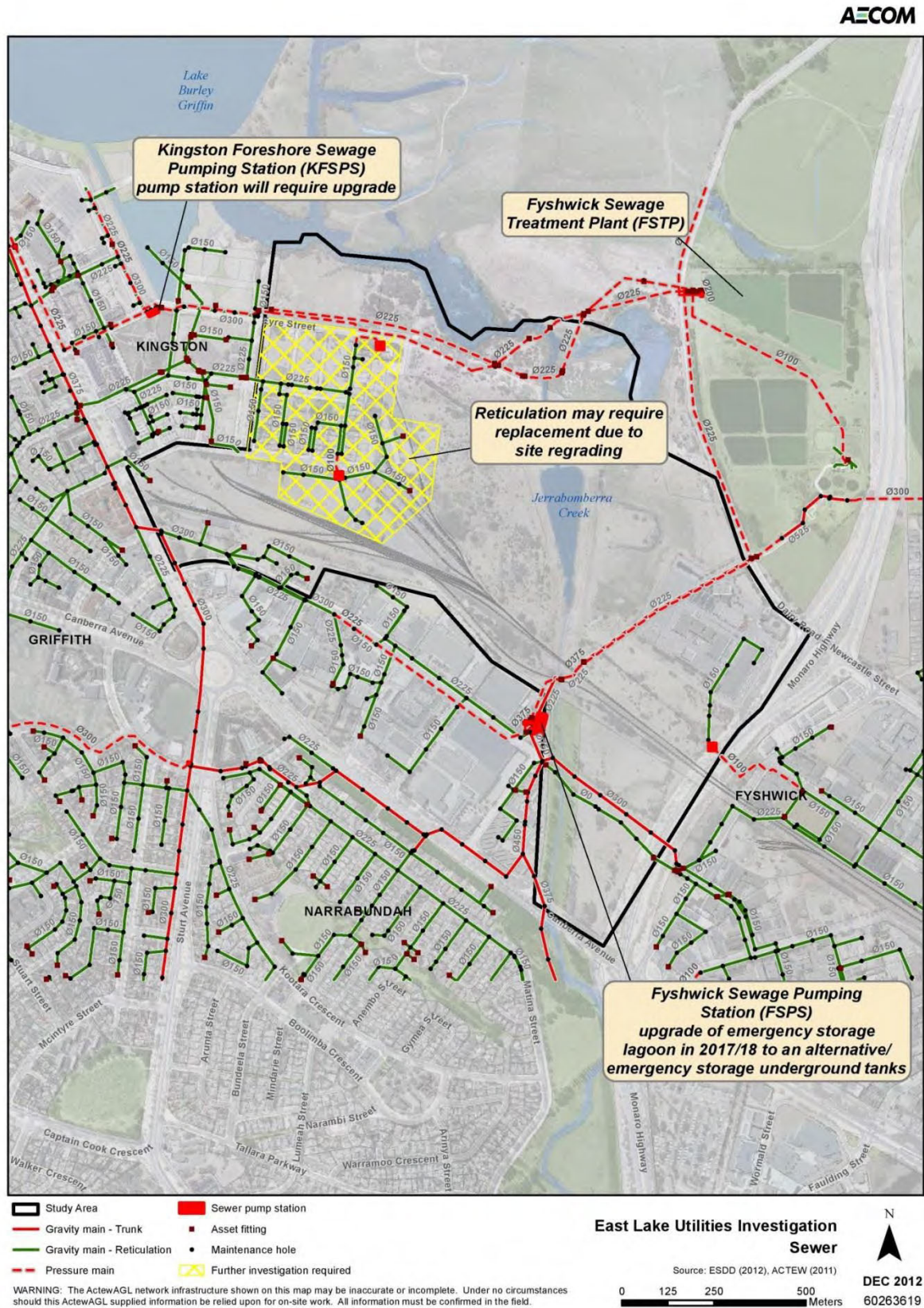


Figure 14 East Lake Utilities Investigation – Stormwater

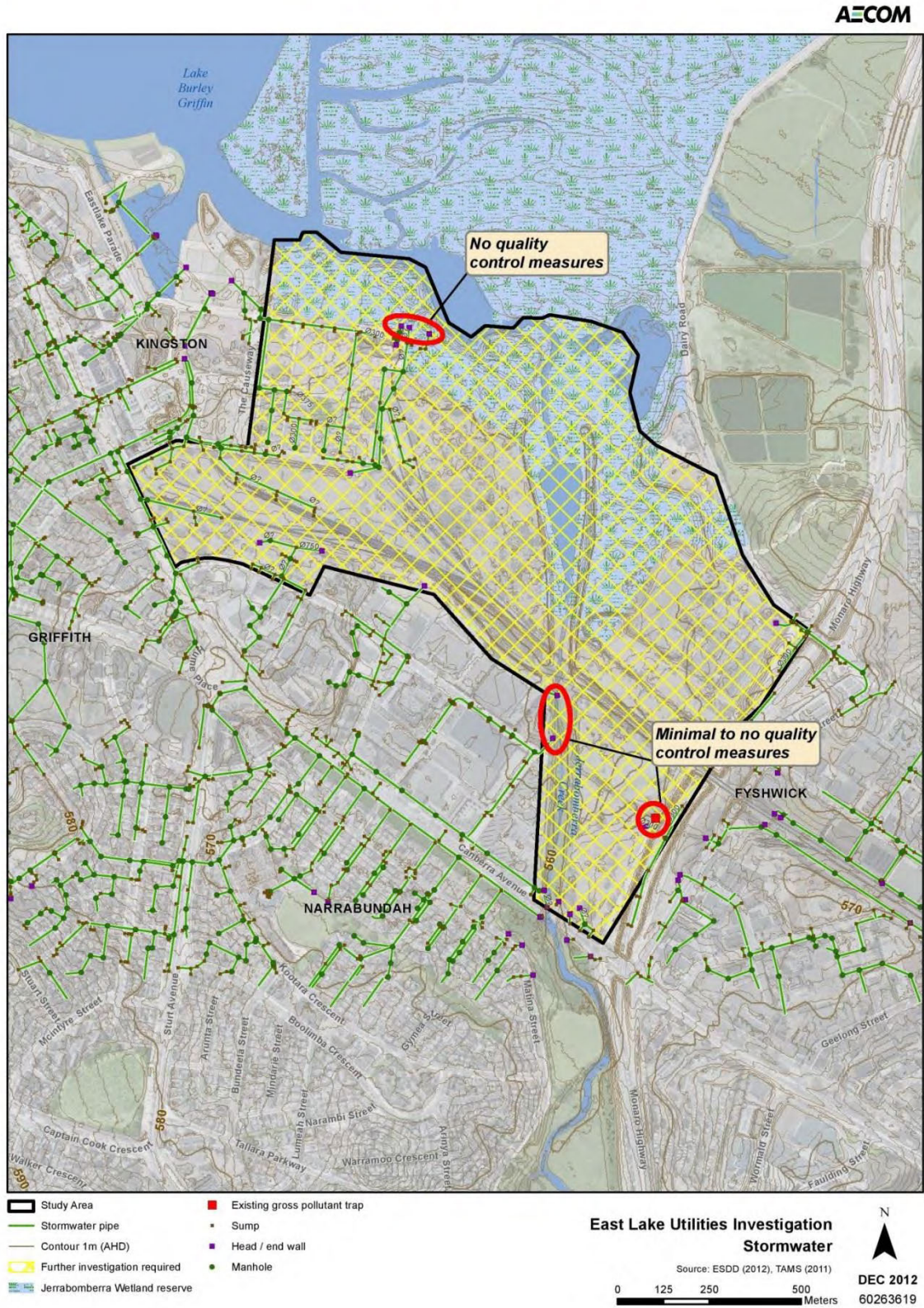
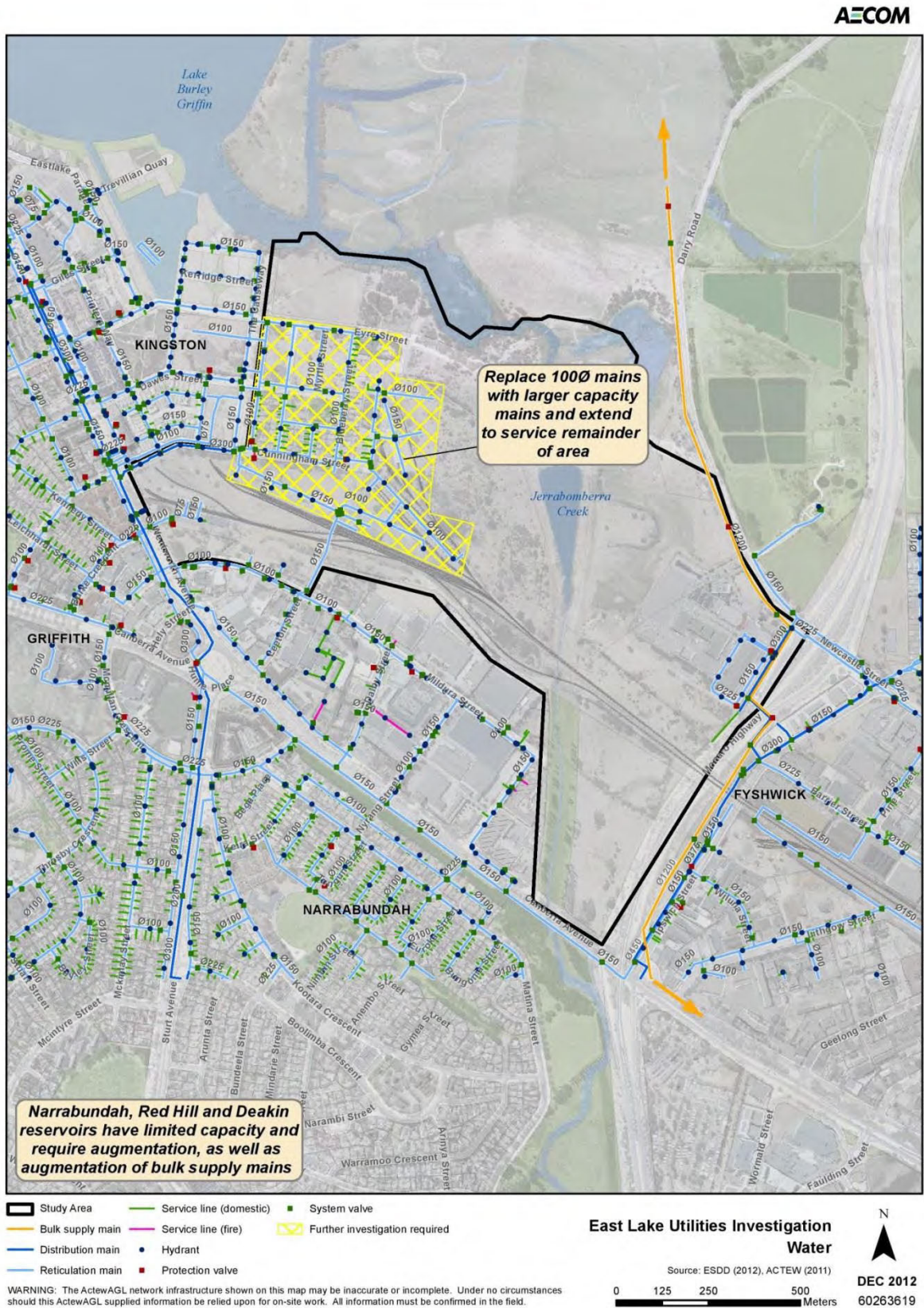


Figure 15 East Lake Utilities Investigation – Water



3.4 Identified Constraints

Following a review of previous investigations undertaken within the Site (Section 2.1), AECOM identified the following key constraints associated with preparation of the Site.

3.4.1 Overview of Key Constraints

Table 4 (below) provides a summary of the key constraint identified within Sections 3.4.2 to 3.4.4

Table 4 Summary of Key Constraints

IDENTIFIED CONSTRAINT	COMMENT
Geotechnical Constraints	<ul style="list-style-type: none"> - Uncontrolled fill ranging from 3 m – 8 m in depth <ul style="list-style-type: none"> • Excavation material from the Parliament House excavation • Builders waste and rubble • General household wastes • Uncompacted fill materials - Areas of alluvial soils up to 10 m in depth - Presence of Groundwater within Alluvial soils - Potential for ongoing settlement of the fill in its present condition - Unsuitability of the fill in its present condition to support structures and roads
Environmental Constraints	<ul style="list-style-type: none"> - The intrusive investigations revealed six primary areas of potential contamination within the soil. <ul style="list-style-type: none"> • It should be noted that during the site investigation works not all areas identified to potentially contain contamination were intrusively investigated (including the rail corridor) • Isolated hydrocarbon contamination primarily located within the western portion of the Site • Isolated heavy metal contamination primarily located within the western portion of the Site • Asbestos material located within uncontrolled fill materials • In the landfill areas (central portion of the Site), groundwater appeared to have also locally been impacted by nitrogen, sulfate, phosphorus, chloride, ammonia, alkalinity and fluoride) It should be noted that at the time of this report these additional works had not yet been completed - Additionally, the Auditor considered that further investigation was required for groundwater, landfill gas and surface water (in relation to the potential for asbestos migration) - As such, it is considered that there is the potential for contamination to exist onsite which has not yet been characterised and that further assessment works should be undertaken <ul style="list-style-type: none"> • It should be noted that for the purposes of this feasibility assessment, AECOM has assumed that where building rubble is present within uncontrolled fill material, there is a high probability of ACM impact. The location of builders waste is detailed within Figure 17
Stormwater and Flooding	<ul style="list-style-type: none"> - Previous flood investigations within the site were reviewed to ensure: <ul style="list-style-type: none"> • All development within the Site is above the 100 year ARI flood level with adequate freeboard • All piped stormwater infrastructure can grade at 0.5% minimum grade (preferably 1%) • Identified overland flow paths can have adequate capacity

3.4.2 Geotechnical Constraints

Previous geotechnical investigations undertaken within the East Lake Site have indicated that the majority of the areas proposed for development are covered by landfill or fill of variable thickness, ranging from 3 m-- 3.5 m with local variations up to 8 m.

The composition of the fill materials is also variable. In some areas the composition is highly heterogeneous with a considerable proportion of foreign objects such as pieces of concrete, plastics, glasses, metals, rubbers mixed with soil (Table 5 and Figure 17).

Table 5 Fill Material Encountered

AREA	DESCRIPTION OF FILL MATERIAL
Central landfill	<ul style="list-style-type: none"> - Highly variable, from sandy silt clay to silty clay, red to grey brown, with plastic, wood, metal, glass, steel mesh, bricks, rubber, tyres, concrete, newspapers, batteries, fibrous cement sheeting, scrap metal, paint tins, ash, coal, etc. - Hydrocarbon odours and elevated Photoionisation Detection (PID) readings were noted at a number of locations.
Two smaller landfills immediately south of Jerrabomberra Creek (along Site northern boundary)	<ul style="list-style-type: none"> - Highly variable, from sandy silty clay, sand to clay, with locally plastic, glass, metal, wire and wood.
Landfill north-west of former DAS Fleet site	<ul style="list-style-type: none"> - Variable, from sandy silty clay, sandy silt, to clay, with locally plastic, metal, wire, rubber, concrete.
Landfill south of former DAS Fleet site	<ul style="list-style-type: none"> - Variable, from sandy gravel, sand, sandy silty clay, clayey sand, sandy silt, to clay, with locally glass, metal, plastic, wire, rubber, concrete, fibrous cement sheeting.

Based on a review of previous investigations, the East Lake development site can be divided into three broad geotechnical zones:

- 1) Areas of natural soils, or occasionally shallow fill, over shallow rock. This zone lies primarily along the south and southwest sides of the East Lake area e.g. between the west end of Mildura Street and Canberra Avenue and between Wentworth Avenue and The Causeway. There is also a small area at the intersection of Dairy Road and Monaro Highway.

This area is shown on the geological map as being underlain by either sedimentary rocks of the Canberra Formation (typically siltstone) or Tertiary Age gravel deposits. Geotechnical conditions in this area of the site are not expected to provide a constraint to development.
- 2) Areas of alluvial soils over which sandstone fill from the construction of New Parliament House has been placed. This area is located generally along the north side of Mildura Street and east of Nyrang Street but also includes the platform of the former DAS Fleet depot.

Lightly loaded structures (e.g. warehouses and the CIT) on concrete slab construction in this area are known to have performed well. Geotechnical conditions in this area are not expected to be a significant constraint to development except that multi-storey development is likely to require deep (piled) foundations which may encounter hard sandstone boulders during drilling.
- 3) The remainder of the site is shown on the geological map as being alluvial soils. A geotechnical investigation report prepared by Parsons Brinckerhoff (PB) and including earlier data obtained by PPK indicates that uncompacted fill has been placed over the majority of the area as listed in Table 5. This includes deep fill between the railway line and the former DAS Fleet depot east of Jerrabomberra Creek, and a wide zone extending from where the railway line crosses the Creek in the south east to the northern boundary of the development area east of The Causeway.

The fill material within the site (Figure 16) has been assessed to be unsuitable for founding load bearing structures in its present condition. Any structures built over the landfill would most likely be subjected to excessive total and/or differential settlement resulted from poor densification of the fill layers and lack of material uniformity. The landfill materials are considered suitable for reuse in engineered fills if the foreign objects are screened out from the fill matrix.

Underlying fill material across most of the Site, and occurring on the existing surface outside the areas covered by fill, are alluvial soils up to 7-10 m depth. These have been predominantly logged as stiff/very stiff or medium dense and there is no indication of soft or compressible soils. Groundwater is present within 2 m depth into the natural soils. The presence of the groundwater table needs to be considered in the design of any earthworks due to potential issues associated with excavation.

At potential bridge sites, competent rocks at depths ranging from 7 m – 13 m are available for foundation of the substructures. Alluvium may provide acceptable conditions for shallow footings for lightly loaded structures depending on the type of the structures and loads imposed on the foundations.

Figure 16 Identified Fill Materials - Location and Depth

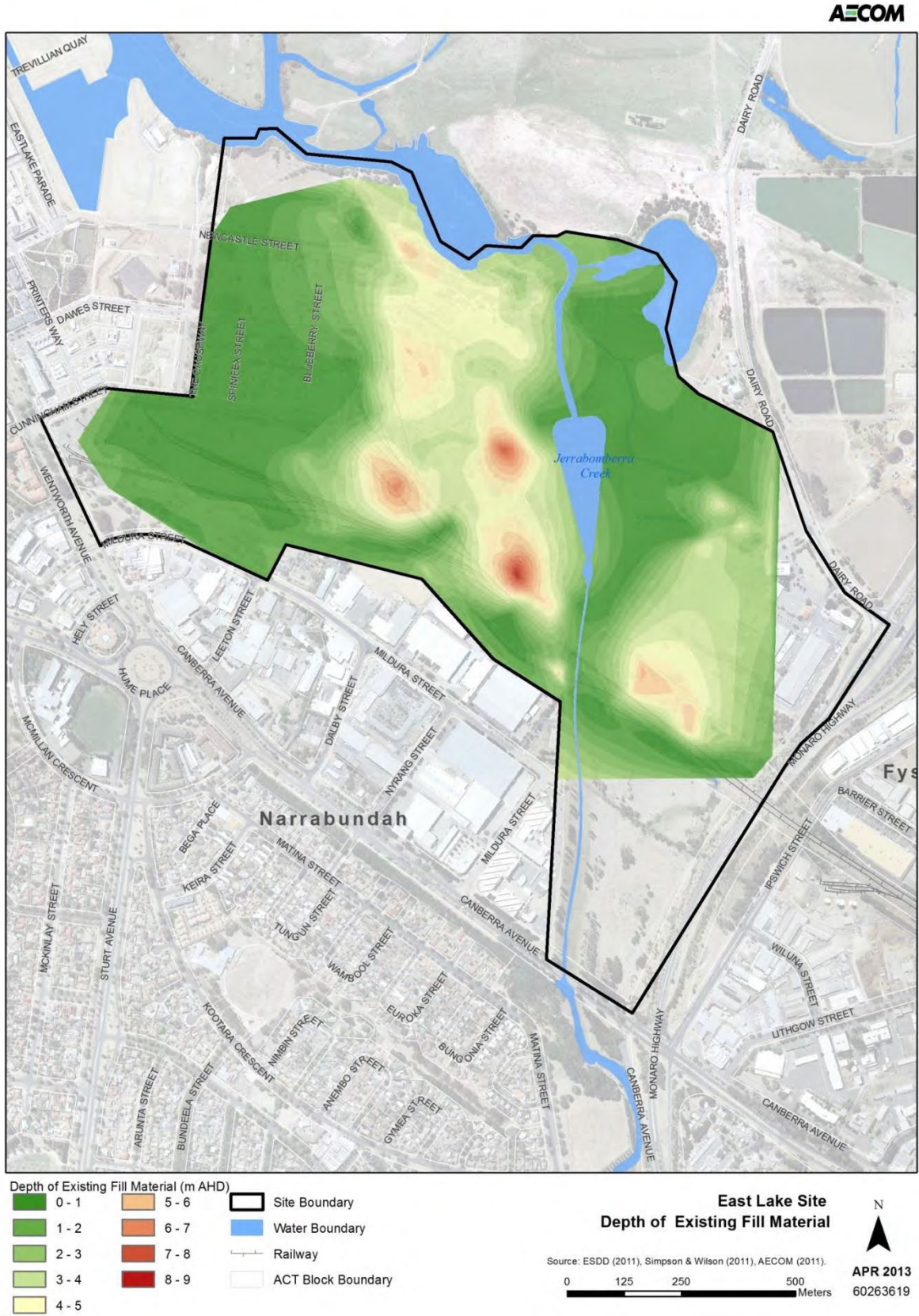
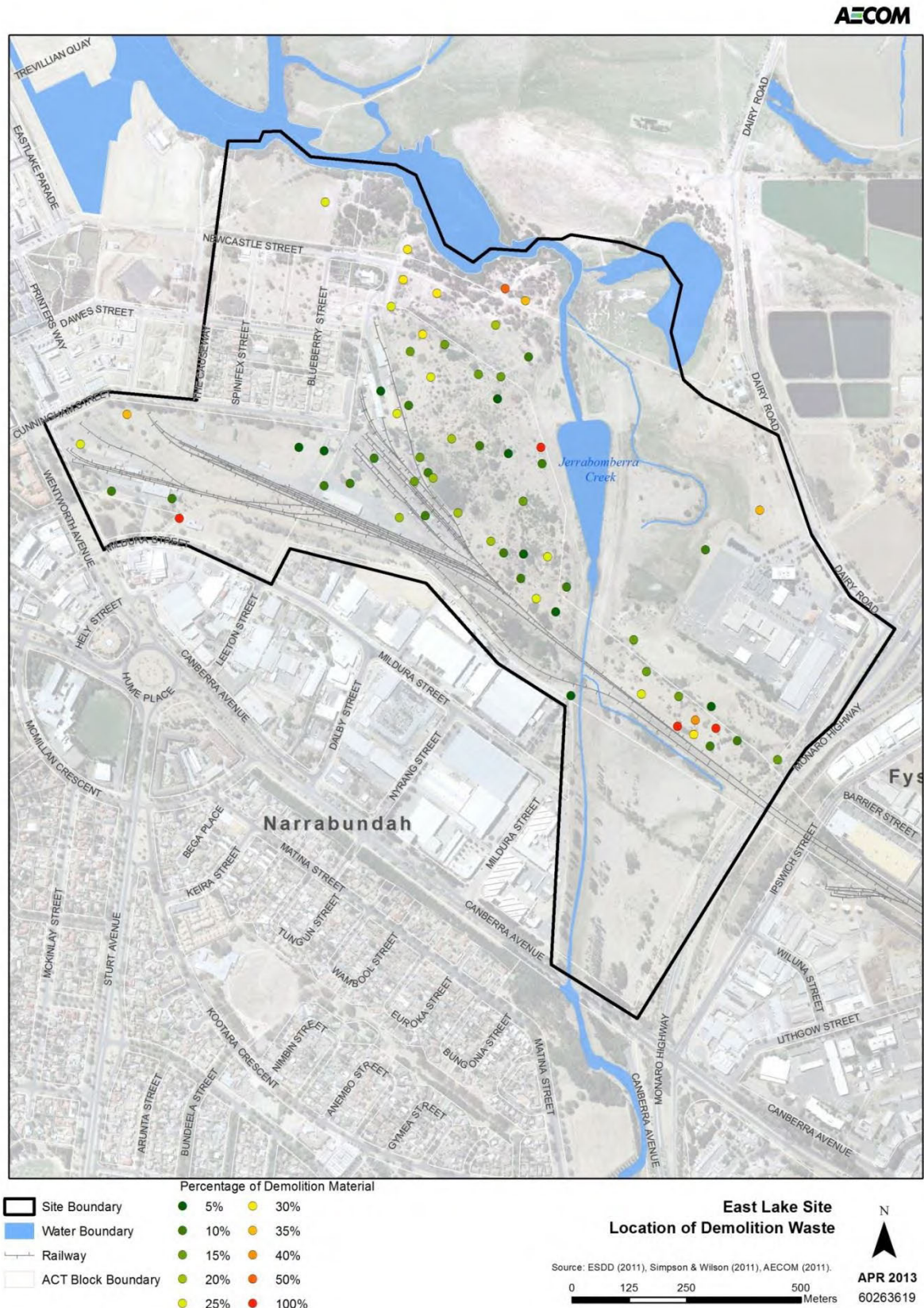


Figure 17 Location of identified demolition waste



3.4.3 Environmental Constraints

Previous environmental investigations have been conducted at the Site to characterise the contamination and to assess the potential impacts on human health and the environment. AECOM was provided with four previous environmental reports, as summarised below:

- Phase 1 Environmental Site Assessment (Coffey 2005): which included a review of third party information to assess the potential for contamination to exist at the site based on historical and current uses;
- Phase 2 Environmental Site Assessment (Parsons Brinckerhoff 2010): which included an intrusive investigation focussed on the areas identified as having the potential for contamination and an assessment of the risk the potential contaminants and developed of the Conceptual Site Model based on the findings;
- A Remedial Action Plan (Parsons Brinckerhoff 2011): which detailed how the areas identified as having the potential to cause harm should be remediated and managed; and
- A Site Audit Report (WSP 2011): which provided an assessment of the adequacy of the documents listed above.

AECOMs review of these reports are summarised in the following sections.

3.4.3.1 Coffey (2005) “Phase 1 Environmental Site Assessment, East Lake Urban Renewal Project, Fyshwick, ACT” dated 19 October 2005 and referenced: C7908/1-AE

Based on their review of the third party information relating to the Site, Coffey Geosciences Pty Limited (Coffey) identified potential areas of environmental concern (AEC) and contaminants of potential concern (CoPC) , as summarised on Table 6.

Table 6 Areas of Environmental Concern (AEC) and Potential Contaminants

COFFEY 2005 AEC	CONTAMINANTS OF POTENTIAL CONCERN	COFFEY COMMENTS
<ul style="list-style-type: none"> - ACT Rail land - Block 2 Section 47 - Fyshwick divided into: <ul style="list-style-type: none"> • A: Former Fuel Storage • B: Former Landfill • C: Fouled Ballast and assorted Fill • D: Former Turntable • E: Railway Museum • F: Miniature Railway 	<ul style="list-style-type: none"> - Total Petroleum Hydrocarbons (TPH), - Benzene, Ethyl-Benzene, Toluene and Total Xylenes (BTEX) - Heavy metals - Asbestos, - Poly Aromatic Hydrocarbons (PAH) - Polychlorinated Bi-Phenyls (PCB), - Organo-Chlorine Pesticides (OCP) 	<ul style="list-style-type: none"> - Potential contamination from leakages or spills associated with fuel tanks or spills of hydrocarbon fuels. Potential contamination from waste oil and fouled ballast. Potential contamination with heavy metals from landfill leachate - Potential hydrocarbon impacts from former turntable identified from previous sampling. Further assessment required - Oil stained areas in and around workshed and coal store. Leakage from batteries and potential asbestos from train parts - Waste fill materials exposed in cuttings including potential asbestos cement board. Fuel and chemicals stored on site. Ash and clinker on track
<ul style="list-style-type: none"> - Service Station and refuelling facilities Block 2 and 3, Section 25, Griffith. Block 2, Section 26, Griffith 	<ul style="list-style-type: none"> - TPH, BTEX, PAH 	<ul style="list-style-type: none"> - Potential contamination from leakages or spills associated with fuel tanks or spills of hydrocarbon fuels. Potential contamination from waste oil
<ul style="list-style-type: none"> - “Causeway Tips” municipal Landfills <ul style="list-style-type: none"> • Block 20, Section 6, Kingston • Block 1, Section 74, 	<ul style="list-style-type: none"> - TPH, BTEX, heavy metals, PCB, asbestos, PAH, nutrients, organics and 	<ul style="list-style-type: none"> - Potential contamination from materials within the landfill, leachate to groundwater/nearby water courses

COFFEY 2005 AEC	CONTAMINANTS OF POTENTIAL CONCERN	COFFEY COMMENTS
<ul style="list-style-type: none"> Fyshwick. Block 1, Section 66, Fyshwick 	others	
<ul style="list-style-type: none"> Department of Agriculture, Fisheries and Forestry Field Research Station Block 2, Section 6, Fyshwick 	<ul style="list-style-type: none"> Potential storage of Hazardous Materials 	<ul style="list-style-type: none"> Potential contamination from chemicals/radioactive materials used on site
<ul style="list-style-type: none"> Fuel Storage, Municipal Depot Block 15, 19, 24 and 26 Section 6, Fyshwick Block 18, Section 30, Fyshwick 	<ul style="list-style-type: none"> TPH, BTEX, PAH 	<ul style="list-style-type: none"> Potential contamination from leakages or spills associated with fuel tanks or spills of hydrocarbon fuels Potential contamination from waste oil
<ul style="list-style-type: none"> Service Station and refuelling facilities Block 6, Section 6, Fyshwick Block 4 and 7, Section 7, Fyshwick 	<ul style="list-style-type: none"> TPH, BTEX, PAH and lead 	<ul style="list-style-type: none"> Potential contamination from leakages or spills associated with fuel tanks or spills of hydrocarbon fuels Potential contamination from waste oil
<ul style="list-style-type: none"> Uncontrolled Fill Section 39 Fyshwick 	<ul style="list-style-type: none"> None specified 	<ul style="list-style-type: none"> Sourced from excavation for New Parliament House May contain boulders – therefore potential geotechnical constraint Low environmental risk
<ul style="list-style-type: none"> Municipal Landfill Block 12 Section 38 Fyshwick 	<ul style="list-style-type: none"> TPH, BTEX, heavy metals, PCB, asbestos, PAH, nutrients, organics and others 	<ul style="list-style-type: none"> Potential contamination from materials within the landfill, leachate to groundwater/nearby water courses. No information on age or depth of fill recorded during desk top study
<ul style="list-style-type: none"> Former DAS Fleet refuelling Facility and municipal landfill Block 11 Section 38, Fyshwick 	<ul style="list-style-type: none"> TPH, BTEX, heavy metals, PCB, asbestos, PAH 	<ul style="list-style-type: none"> Potential contamination from leakages or spills associated with fuel tanks or spills of hydrocarbon fuels Potential contamination from waste oil Potential contamination from materials within the landfill, leachate to groundwater/nearby water courses It is understood that the site is currently subject to a Phase 2 ESA.
<ul style="list-style-type: none"> AEC 10: Fyshwick Sewage Treatment Works (FSTW). 	<ul style="list-style-type: none"> Faecal coliforms, nitrogen, phosphorous, Heavy metals 	<ul style="list-style-type: none"> Potential contamination of soil, surface water and groundwater in the vicinity of the FSTW

3.4.3.2 Parsons Brinckerhoff Australia Pty Limited (2010) “East Lake Development – Environmental Site Assessment” dated 23 September 2010 and referenced 2160807A PR_2085_RevC

Parsons Brinckerhoff Australia Pty Limited (PB) completed an intrusive investigation of 99.36 ha of the 471 ha of the total site area. The intrusive works involved drilling additional wells, excavating test pits and collecting soil, groundwater and surface water samples for laboratory analysis. Landfill gas measurements were also undertaken.

The following is a summary of the contamination encountered.

Soil

Samples were analysed for contaminants which had the potential to exist in elevated concentrations onsite based on historical and current use of the areas. Areas exceeding the health-based assessment criteria are described within Table 7.

Table 7 Summary of the Known Soil Contamination at the Site

CONTAMINANT OF CONCERN	AREA OF SITE	CONCENTRATION	GUIDELINE EXCEEDED	GUIDELINE CONCENTRATION	LOCATION
TPH C ₁₀ -C ₃₆	Northeast of the 'Robbo's Pet Barn' building	12,500 mg/kg	NSW EPA (1994) Guidelines for Assessing Service Station Sites.	1,000 mg/kg	C_TP24_4.0
TPH C ₁₀ -C ₃₆	Central landfill, north-west of the silt trap	3,960 mg/kg	NSW EPA (1994) Guidelines for Assessing Service Station Sites.	1,000 mg/kg	TP11_2.0
Benzo(a)Pyrene	Southern part of railway museum	1.2 mg/kg	Standard residential (NEHF A)	1 mg/kg	C_BH11_1.0
Benzo(a)Pyrene	Area of railway museum where steam locomotives were loaded with coal	1.2 mg/kg	Standard residential (NEHF A)	1 mg/kg	C_MW13_1.0
Lead	Southern part of central landfill	1,200 mg/kg	Standard residential (NEHF A) Open space (NEHF E) Environmental Investigation Level	300 mg/kg 600 mg/kg 600 mg/kg	C_TP33_1.0
Lead	North of the train station	2,900 mg/kg	Standard residential (NEHF A) Open space (NEHF E) Residential with minimal access to soil (NEHF D) Commercial / Industrial (NEHF F) Environmental Investigation Level	300 mg/kg 600 mg/kg 1,200 mg/kg 1,500 mg/kg 600 mg/kg	TP02_0.2

PB considered that the hotspots and aesthetic issues (ash, staining etc) encountered may locally create risks for the proposed redevelopment of the Site, particularly if the site was redeveloped for sensitive land use. PB also stated that while the existing rail corridor was excluded from the investigation, it was considered that the rail corridor was likely to be affected by contamination. The location of identified asbestos and hydrocarbon impact is presented within Figure 18 and Figure 19 respectively.

Surface Water

Water quality was assessed in Jerrabomberra Creek. The investigation found concentrations of most compounds analysed (including total petroleum hydrocarbons [TPH], benzene, toluene, ethylbenzene and xylenes [BTEX], suite of eight metals [arsenic, chromium, cadmium, copper, lead, nickel, mercury, zinc], polycyclic aromatic hydrocarbons [PAH], polychlorinated biphenyls [PCB], ammonia, major ions, minor ions, total organic carbon, nitrate, nitrite and the biological oxygen demand) were found to be similar in the upstream, mid-stream and downstream samples, suggesting the site had “*little influence on surface water quality*”.

Groundwater

- Groundwater was encountered during fieldworks between 0.8 m to 7.0 m below ground level (bgl) and flowed in an east/northeast direction towards Jerrabomberra Creek.
- Petroleum hydrocarbons were detected in groundwater at location C_MW07 (a fuelling area north of the train station) at concentrations below the PB adopted site assessment criteria and locations MW02 (south of central landfill) marginally greater than the site assessment criteria. Naphthalene was also detected at MW02, although at a concentration below the PB adopted site assessment criteria.
- In the landfill areas, groundwater appeared to have also locally been impacted by nitrogen, sulfate, phosphorus, chloride, ammonia, alkalinity and fluoride. Concentrations of some compounds exceeded the aquatic habitat criteria and/or for recreational use. Concentrations were generally lower in the monitoring wells positioned down-hydraulic gradient of the landfill areas.

Details of groundwater conditions encountered during site investigation works are presented below within Table 8.

Table 8 Summary of the Known Groundwater Contamination at the Site

CONTAMINANT OF CONCERN	CONCENTRATION	GUIDELINE EXCEEDED	GUIDELINE CONCENTRATION	LOCATION
TPH C ₁₀ -C ₃₆	610 µg/l	ACT EPA 2011	600 µg/l	MW02
Copper	Maximum of 13 µg/l	95% Fresh water trigger value (ANZECC 2000) Aquatic Habitat	2 µg/l	most samples exceed Aquatic Habitat criterion (2 µg/L) particularly C_MW07 (13 µg/L), C_BH01, C_MW02 and GW11 (9 µg/L)
Zinc	Maximum of 290 µg/l	95% Fresh water trigger value (ANZECC 2000) Aquatic Habitat	5.0 µg/l	All Samples
Chloride	Maximum of 160 µg/l	95% Fresh water trigger value (ANZECC 2000) Aquatic Habitat	2 µg/l	All Samples
Total alkalinity as CaCO ₃	1,000 µg/l	Recreational	500 µg/l	C_MW13
Total alkalinity as CaCO ₃	670 µg/l	Recreational	500 µg/l	GW110
Total alkalinity as CaCO ₃	630 µg/l	Recreational	500 µg/l	GW39
Nitrate	38 µg/l	Recreational	10 µg/l	C_MW12
Ammonia	0.4 µg/l	Recreational	0.01 µg/l	C_MW19
Ammonia	1.3 µg/l	Recreational	0.01 µg/l	GW115
Ammonia	4.1 µg/l	Recreational	0.01 µg/l	GW39
Ammonia	0.2 µg/l	Recreational	0.01 µg/l	MW02

Landfill Gas

PB noted that while some aerobic and anaerobic degradation appeared to be occurring locally within and hydraulically downgradient of the central landfill and the landfill located along Jerrabomberra Creek, methane was not detected in any of the wells sampled.

Conclusion

The Phase 2 ESA concluded the Site was unsuitable for the uses described in the 'preferred design' without remedial works.

3.4.3.3 PB (2011) "Remediation Action Plan East Lake Urban Renewal Project, Fyshwick, ACT" dated 18 March 2011 and referenced 2160807A PR_2626_RevD

The Remedial Action Plan (RAP) was based on the results of the ESA undertaken by PB in 2010. PB stated that the risks were considered to be low but some remedial works were required to mitigate potential exposure.

The remediation strategy proposed targeted soil hot spot contamination and recommended a combination of remediation techniques for the remaining areas of fill to achieve the objective (i.e. to outline the areas that require remediation to render the site suitable for the proposed end use) and to conduct monitoring on groundwater to determine the extent of the groundwater contamination following the removal of soil hotspots.

3.4.3.4 WSP (2011) "Site Audit Report, proposed East Lake Development ACT" dated 15 July 2011 and referenced 1715 SAR03_Final

Rebeka Hall (an accredited NSW EPA Contaminated Sites Auditor) completed an Audit Report (in accordance with ACT Environment Protection Authority Contaminated Sites Environment Protection Policy and the NSW DEC (2006) Contaminated sites Guidelines for the NSW Auditor Scheme – Second Edition) for the following parcels of land in the project area:

- Block 7 Section 11 Kingston (excluding the Canberra Railway Station, the rail corridor and Coounda Court);
- Block 2 Section 39 Kingston;
- Block 3 Section 39 Kingston;
- Block 4 Section 11 Kingston;
- Block 10 Section 47 Fyshwick;
- Block 11 Section 47 Fyshwick;
- Block 14 Section 38 Fyshwick;
- Block 20 Section 6 Kingston;
- Block 1 Section 74 Fyshwick;
- Part of Block 2 Section 66 Fyshwick; and
- Block 8 Section 30 Fyshwick.

The purpose of the report was to ensure that investigations undertaken within the site were adequate to characterise the soil and groundwater contamination at the Site to such an extent that the Site could be rendered suitable for use (mixed residential, open space and commercial/industrial) in accordance with the proposed remediation strategy.

The Auditor concluded that the sampling strategy undertaken by PB was considered to be adequate to establish a suitable contamination model, although considered that the absence of surface water sampling for asbestos was not compliant to the Guidelines for the Assessment, Remediation and Management of Asbestos – Contaminated Sites in WA (May 2009). The Auditor recommended that the remediation and management options associated with the WA (2009) guidelines be adopted as part of the remedial strategy for the Site.

The Auditor also noted:

- That non-compliant methodologies were employed for landfill gas assessment. The Auditor considered that there was still potential for landfill gas and that it should be investigated further;
- The impacts to groundwater were considered to be localised but also required further assessment and remediation;
- That the fill be managed under a 'worst-case' scenario. The Auditor concluded that "*the environmental investigation did not identify any gross contamination of soil and/or groundwater*".

Figure 18 Identified location of known asbestos sheeting

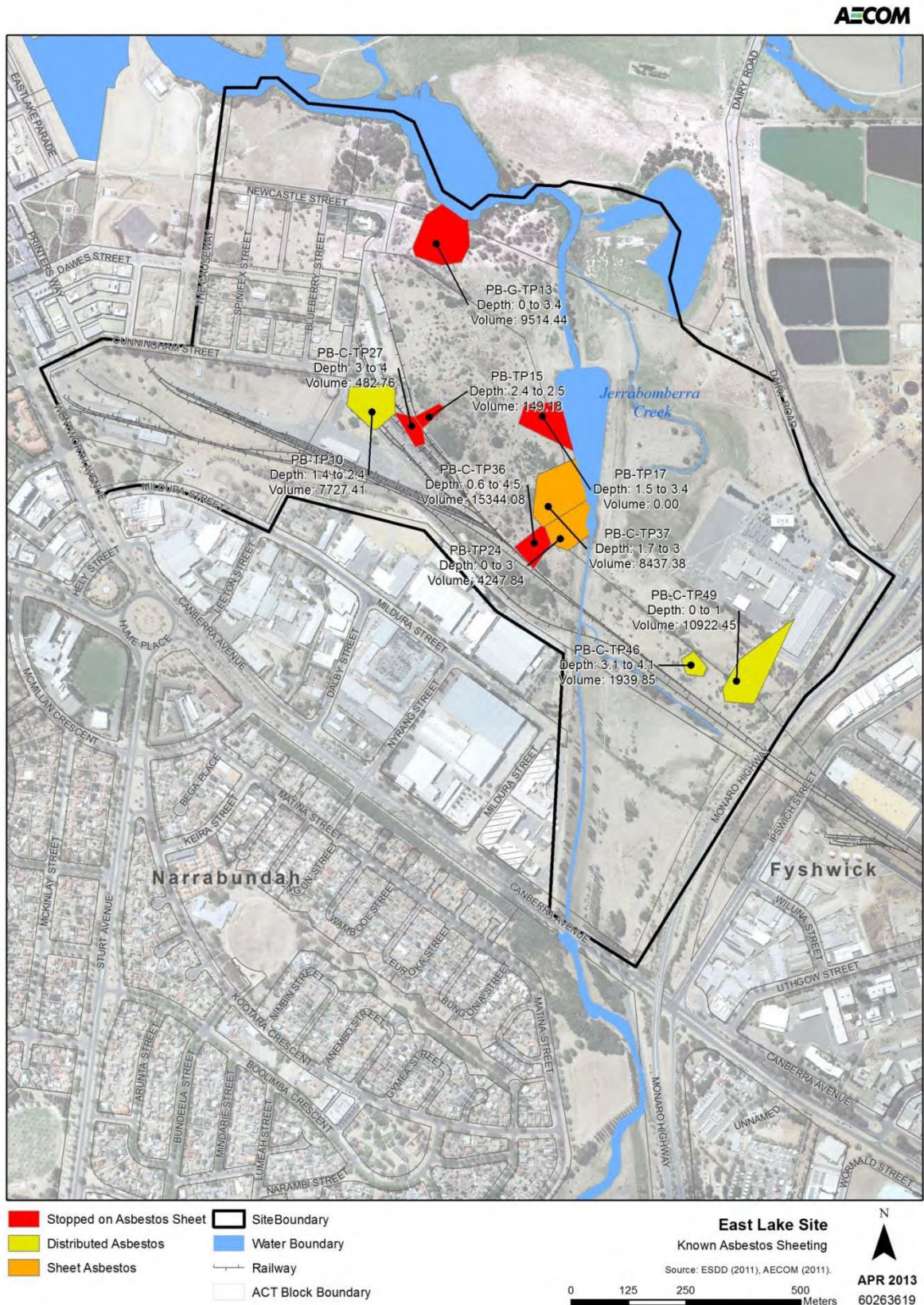
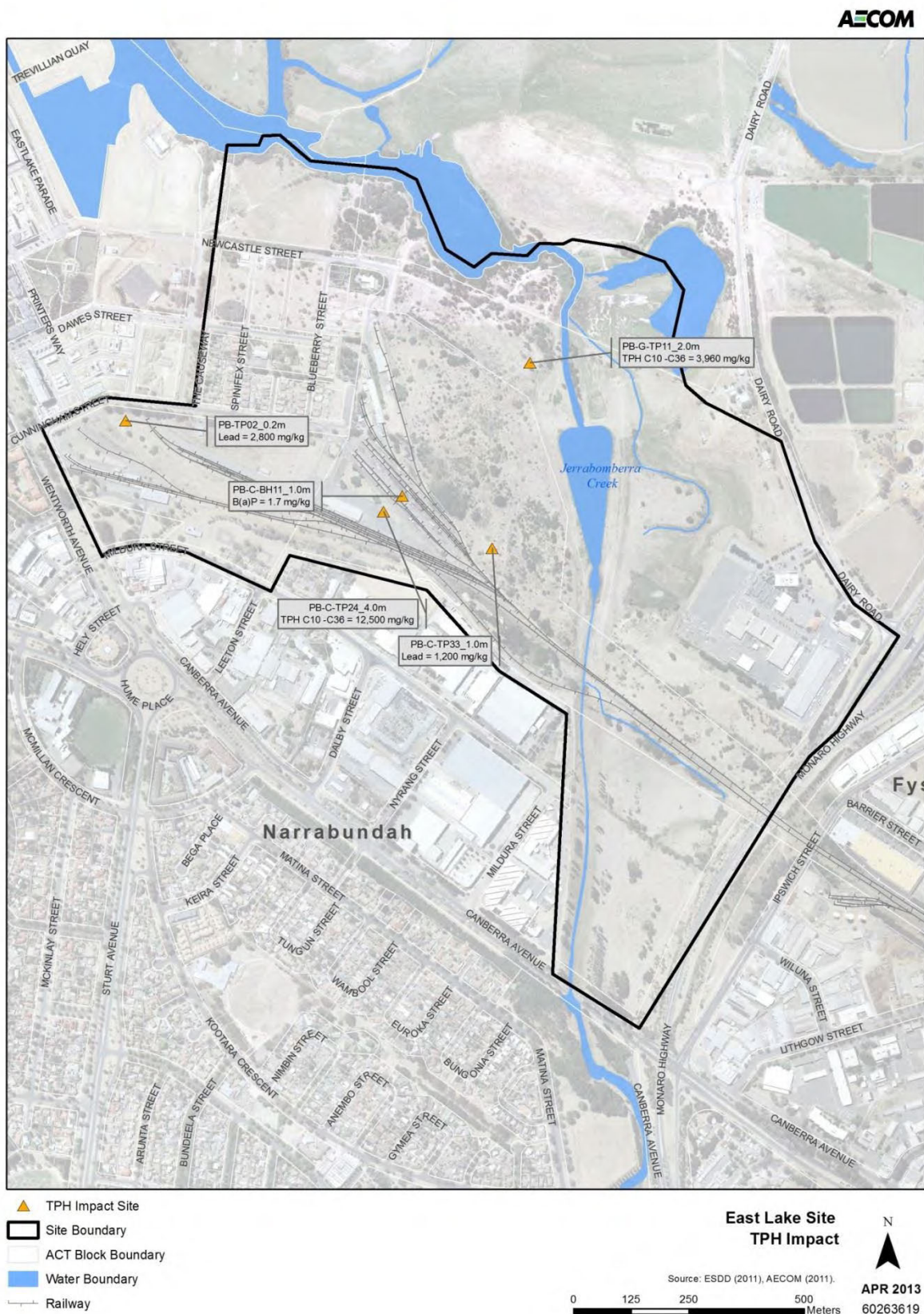


Figure 19 Identified Site Contamination (non-asbestos)



3.4.4 Stormwater Drainage and Flood Protection Constraints

3.4.4.1 Regional Flooding

As discussed within previous Sections, the Site is bounded by the Jerrabomberra Wetlands to the North, the Jerrabomberra Creek and "Silt Trap to the East, Commercial development and the residential suburb of Narrabundah to the South and the Kingston Foreshore Development Precinct to the West.

A review of previous flood studies was undertaken to determine the 100 year ARI peak flood level surrounding the Site.

The following recent flood studies have been undertaken for the Molonglo River and Jerrabomberra Creek:

- Molonglo Catchment and Scrivener Dam Flood Hydrology Review – Phase 2, Hydraulics and Inundation Mapping Report (SKM, June 2011)
- East Lake Pond and Lake at Symonston Feasibility Study – Options and Concept Design Report (Cardno, December 2011)

The peak flood levels presented in the SKM (2011) and Cardno (2012) studies were used to estimate the 100 year ARI peak flood level and flood inundation extent adjacent the East Lake Site.

The minimum development level was then determined by applying a freeboard to the estimated 100 year ARI peak flood levels. Freeboard is the difference between the development level and the peak flood level.

It is noted that a 300 mm freeboard has been adopted adjacent to Jerrabomberra Creek and a 500 mm freeboard adjacent to the Molonglo River (northern boundary of the Site). The larger freeboard was adopted along the northern boundary of the Site due to uncertainties associated with the 100 year ARI peak flood level in this location resulting from cross section separation in the SKM (2011) study.

It is also noted that no flood modelling surrounding the Site was undertaken by AECOM for this study.

The estimated 100 year ARI flood inundation extent is presented in Figure 20. It can be seen from Figure 20 that the 100 year ARI flood event will inundate the north-west corner of the Site and an area east of Jerrabomberra Creek, however the remainder of the Site is immune to flooding from this event. It is also noted that the former DAS site, including an area immediately between this site and the existing railway alignment will be inundated by the 100 year ARI flood event.

The land between the Monaro Highway and Jerrabomberra Creek is completely inundated during the 100 year ARI flood event.

3.4.4.2 Stormwater Drainage and Site Regrading

Based on a review of the draft PDF presented within Section 2.3 AECOM determined the stormwater catchments within the Site and prepared a minimum development level map for the Site. This minimum development level ensures:

- All development within the Site is above the 100 year ARI flood level with adequate freeboard. As described above, a 300 mm freeboard has been adopted adjacent Jerrabomberra Creek and a 500 mm freeboard adopted adjacent to the Molonglo River (northern boundary of the Site)
- All piped stormwater infrastructure can grade at 0.5% minimum grade (preferably 1%) and discharge above the 5 year ARI peak flood level in Jerrabomberra Creek and the Molonglo River floodplain with adequate pipe cover
- Overland flow paths can have adequate capacity.

The corresponding catchments for the minimum development level are presented in Figure 21.

Based on the required catchments specified above, the required minimum development surface levels were calculated to range from:

- 559.3 m AHD – located central portion of the Site, located adjacent to the "Silt Trap"; to
- 563.5 m AHD – located on the western boundary of the Site adjacent to the residential suburb of Narrabundah.

The required minimum development levels are presented in Figure 22.

Figure 20 East Lake Site 100 year ARI Flood Inundation Extent

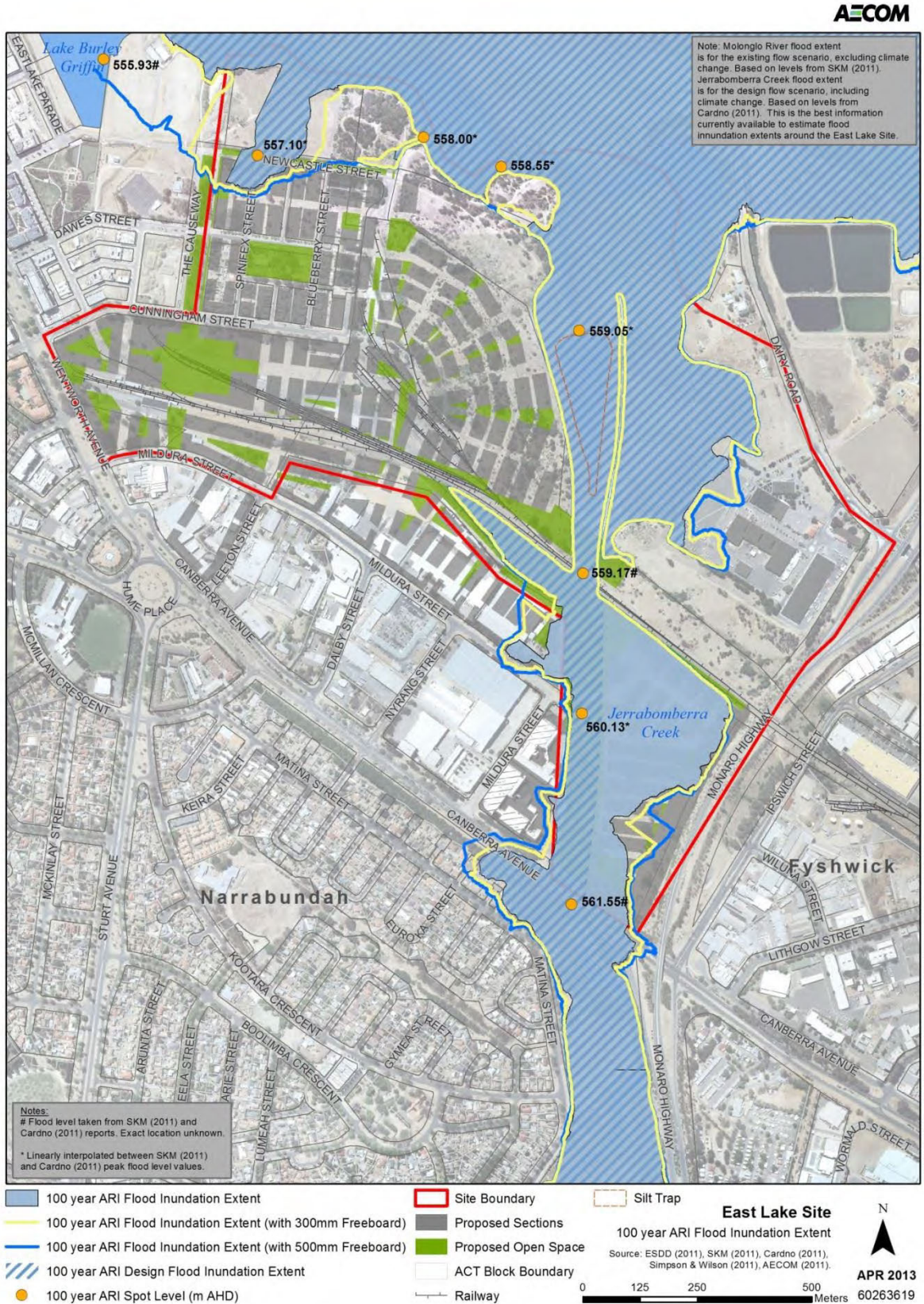


Figure 21 Stormwater Catchments – December 2011 PDF

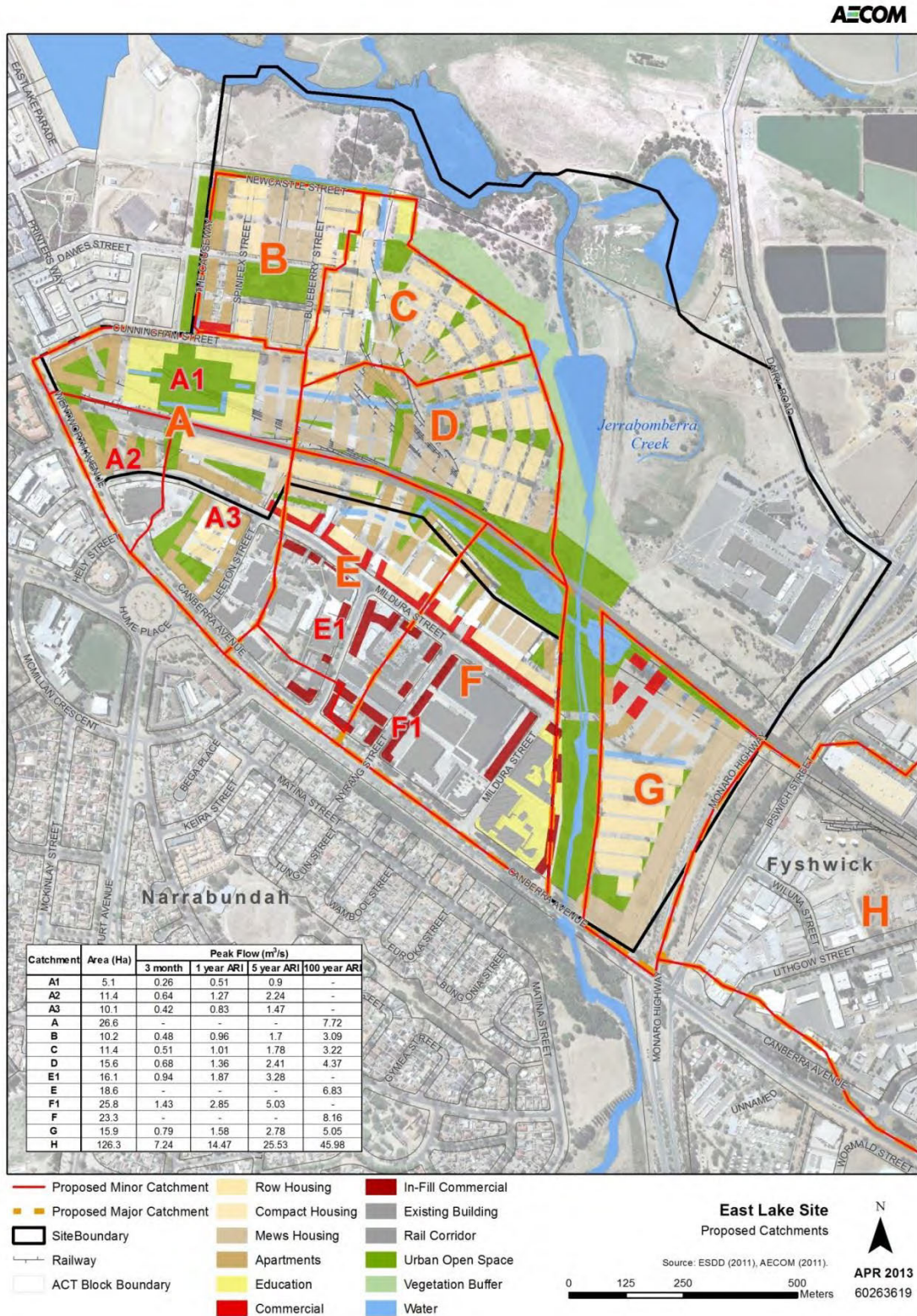
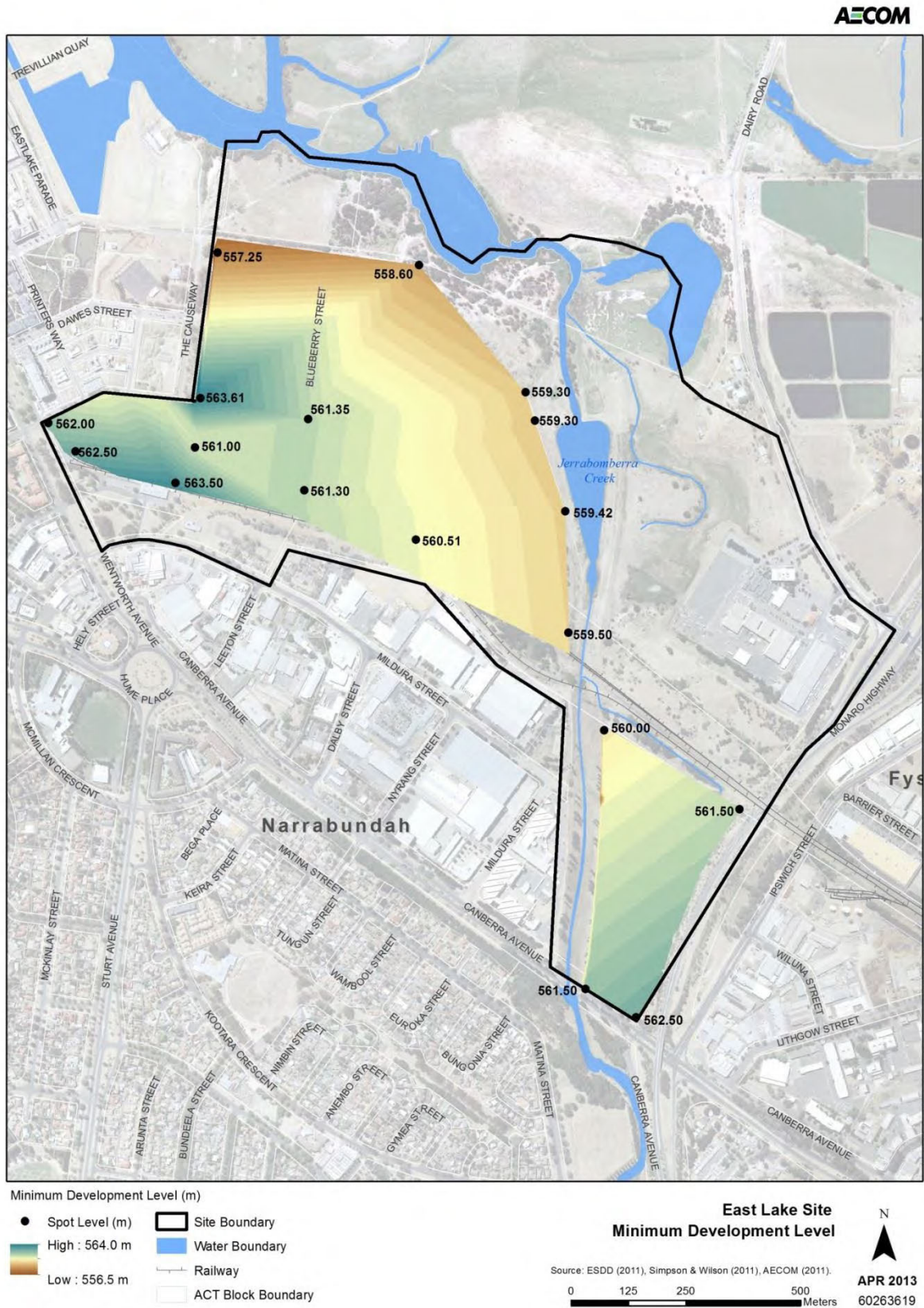


Figure 22 Required Minimum Development Levels – December 2011 Draft PDF



3.4.5 Stormwater Quality Management and Water Sensitive Urban Design Requirements

The ACT Waterways WSUD General Code identifies that objectives for stormwater quality management should be achieved by the combination of works undertaken by the ACT Government, through its development and capital works program, and by private sector works undertaken in new developments and redevelopments.

The responsibility for meeting targets on development or redevelopment sites lies with the developer or builder, while responsibility for meeting the regional or catchment-wide targets lies with the Government.

The development and regional stormwater quality improvement targets are presented below in Table 9. These targets refer to the reduction in pollutant export compared to an urban catchment with no water quality management controls.

Table 9 Stormwater Quality Improvement Targets

POLLUTANT	DEVELOPMENT OR REDEVELOPMENT	REGIONAL OR CATCHMENT WIDE
TSS	60%	85%
TP	45%	70%
TN	40%	60%

Note: Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN)

It is important that sufficient land is made available during the planning stages for water quality improvement technologies to ensure that the water quality objectives can be achieved for the Site.

Stormwater quality improvement devices (SQIDs) were sized using the MUSIC software package to ensure that the developer and regional water quality targets can be achieved for the Site and that adequate land is set aside for construction of water quality infrastructure.

Local WSUD measures incorporated into the MUSIC model include rainwater tanks (in accordance with the ACT WSUD General Code), street-scale rain gardens, swales, bio-retention wetlands at the end of swales and gross pollutant traps (GPTs). It is noted that a large percentage of the lots have an area less than 300 m² and therefore do not require having a rainwater tank installed. The developer water quality targets are consequently largely achieved with the use of street-scale rain gardens.

The regional water quality targets can be achieved with off-line SQIDs located to the north and east of the Site boundary. These SQIDs will comprise a combination of wetlands and bio retention basins.

4

EAST LAKE URBAN RENEWAL SITE PREPARATION OPTIONS DEVELOPMENT

EAST LAKE SITE PREPARATION FEASIBILITY STUDY

4.0 East Lake Urban Renewal Site Preparation Options Development

SECTION SUMMARY

- This section provides an overview of the development of the four Site Preparation Scenarios undertaken by AECOM for incorporation into subsequent opinion of cost estimates and cost benefit analysis
- The four potential site preparation scenarios were considered in the context of site specific conditions detailed within previous investigations and key constraints identified during the course of this assessment
- It should be noted that due to the widespread nature of builders waste within the Site, and the Site auditor's requirements for fill to be managed in a worst case scenario, AECOM's options development assumes that all areas containing builders waste should be treated as potentially containing asbestos.
- Following development of Options 1–4, AECOM undertook an analysis of site preparation options against the following key criteria:
 - Technical, logistical, timing and financial feasibility ; and
 - Sustainability issues associated with onsite re-use, CO2 emissions and community response
- All fill volume calculations were based on the 2012 site survey and revised fill volume calculations undertaken by AECOM and informed by previous investigations for the Site as detailed within Section 2.1

4.1 Site Remediation Options

As outlined within the PB (2011) Remedial Action Plan (RAP), the remediation/site preparation goals for the Site were to:

- Remediate the impacted soils/fill materials at the Site to an acceptable standard for the desired end use (as detailed in the preferred design document including residential, commercial, industrial and open space) that will not pose unacceptable risk to human health or the environment;
- Remediate any additional impacted soils/fill that are found to be contaminated during redevelopment works that may not have been identified in previous investigations localised impacts may be present due to the heterogeneous nature of fill materials;
- Consider the sustainability principles pursuant to the East Lake Urban Redevelopment vision in the remedial design to reduce offsite disposal of materials and maximise reuse of excavated material to render the land geotechnically suitable for the proposed end uses; and
- Validate materials to be re-used onsite, and assess where the material may be placed for beneficial re-use without offsite disposal.

Table 10 outlines the site remediation options analysis undertaken within the PB (2011) RAP.

4.2 PB (2011) Remedial Options

The table below outlines the potential remediation options and the interpretation of the suitability of each option identified by PB.

Table 10 PB (2011) Remedial Options Analysis

REMEDICATION METHODOLOGY	DESCRIPTION	ADVANTAGES	DISADVANTAGES	SUITABLE
Onsite bio-remediation	<ul style="list-style-type: none"> - Excavated soils are thoroughly broken down and aerated, mixed with microorganisms and nutrients, stockpiled and aerated in above ground enclosures. 	<ul style="list-style-type: none"> - Cost effective if soils are utilised on-site. - Lower disposal costs. - Limited requirement to import fill material to Site. - Retains material on-site. 	<ul style="list-style-type: none"> - Significant area of Site required to land farm material. - Undefined remediation timeframe. - Potential for odour problems. - Uncertainty of successful results, particularly for the heavy-end hydrocarbons. - Not suitable for metals contamination. 	<ul style="list-style-type: none"> - Unexpected contaminated materials be encountered during excavation works, depending on the nature of the contamination, materials could be bio-remediated. - This may be more cost effective than offsite disposal and is more in line with the redevelopment vision in respect of sustainability.
In-situ treatment	<ul style="list-style-type: none"> - In-situ treatment of impacted soils within the smear zone and saturated zone using in-situ treatment methods such as SVE, steam stripping, ISCO or injection of oxygen releasing compounds. 	<ul style="list-style-type: none"> - Creates minimal disturbance to the Site (no excavation). - Cost effective for large scale site remediation projects of light to mid-weight petroleum hydrocarbons. - Potential to simultaneously remediate dissolved phase hydrocarbons in Site groundwater. 	<ul style="list-style-type: none"> - Not applicable to the kind of contamination encountered at the Site. - Expensive establishment costs. - Potential for odour problems - Requires detailed design, pilot trials and management. 	<ul style="list-style-type: none"> - Not applicable to the kind of contamination encountered at the Site.

REMEDIATION METHODOLOGY	DESCRIPTION	ADVANTAGES	DISADVANTAGES	SUITABLE
Consolidation and/or capping	<ul style="list-style-type: none"> - Risk minimisation approach where impacted soils are managed onsite by capping the ground surface with a clean, impermeable layer of fill material. 	<ul style="list-style-type: none"> - Effectively removes risk to human health by eliminating exposure pathways. 	<ul style="list-style-type: none"> - Importance of capping materials. Contamination would remain in-situ allowing potential off-site migration of contamination and further impacts on groundwater. - Land use limitations - Requirement for an Environmental Management Plan 	<ul style="list-style-type: none"> - Yes - for some areas based on proposed end use.
Excavation and off-site disposal	<ul style="list-style-type: none"> - Excavate impacted materials. - Transport directly to a licensed landfill facility. - Reinststate Site with imported clean fill material. 	<ul style="list-style-type: none"> - Fast – impacted material removed immediately, significantly reducing potential for impact to groundwater. - No storage or treatment problems. - Reduced vapour/odour issues as impacted materials removed from Site. - Minimal design and management costs. 	<ul style="list-style-type: none"> - Transfer of waste to another location. - High costs associated with the disposal and importation of clean fill. - May require some additional testing (including TCLP) to enable waste classification prior to disposal. - Not in accordance of the redevelopment vision. - Sustainability issues related to disposal to landfill. 	<ul style="list-style-type: none"> - Yes, only in areas where contaminant hotspots have been identified in previous investigations or where asbestos material is found to be present. - For other fill materials, excavation and offsite disposal would only be considered a last resort.

REMEDIATION METHODOLOGY	DESCRIPTION	ADVANTAGES	DISADVANTAGES	SUITABLE
Excavation and onsite treatment/processing	<ul style="list-style-type: none"> - Excavate impacted/ geotechnically unsuitable materials. - Segregate components of waste mass, process components appropriately as per EMP 	<ul style="list-style-type: none"> - Relatively fast method. Aligns with the East Lake ULP vision in respect of sustainability by reducing offsite disposal to landfill, recycling of metal and wood components of fill (where suitable) and increasing reuse of suitable material onsite. 	<ul style="list-style-type: none"> - Cost of processing materials for use as sub grade. - May require some additional testing (including TCLP) to validate material prior to reuse. - Storage or treatment problems associated with processed materials that are subsequently found to be unsuitable for reuse. - This strategy may result in cross contamination if processing material containing asbestos fibres, fragments 	<ul style="list-style-type: none"> - Yes – The nature of the fill is generally inert waste with most of the excavation of the fill volume driven by geotechnical factors as opposed to identified contamination.
Natural attenuation	<ul style="list-style-type: none"> - Allowing the contaminants to biodegrade naturally following removal of the contamination source. 	<ul style="list-style-type: none"> - No remedial excavation of Site. Retains materials on site. - Sustainable, cost effective remediation method. 	<ul style="list-style-type: none"> - Slow process. Potential for contamination to further impact on the groundwater aquifer and nearby environmental receptors. - Unlikely to improve the geotechnical characteristics of contaminated fill. 	<ul style="list-style-type: none"> - Limited. Only applicable to some contaminants.

4.3 Site Preparation Scenarios

The PB (2011) RAP indicated that contamination identified within the Site could be successfully remediated and validated to a level commensurate with the proposed land use.

The following three site preparation scenarios were proposed for the Site based on the outcomes of the PB (2011) RAP and subsequent WSP (2011) Strategic Review.

- **Option 1** – Clean environmental hotspots, cap uncompacted fill area as required. Management of general geotechnical and environmental issues would be managed by individual Site developers;
- **Option 2** – Remediate the whole of the fill for geotechnical and environmental contamination by excavation, removal of unsuitable materials and replacement of the soil materials as controlled fill; and
- **Option 3** - Clean environmental hotspots and use partial excavation in conjunction with ground improvement such as impact rolling to improve the geotechnical properties of the Site followed by adequate controlled fill capping.

The specific methodology to be used within each option was established by examining the following key site conditions

Table 11 Site Preparation Conditions

SITE PREPARATION CONDITIONS	COMMENTS
Existing Surface Level	- As detailed within the Site survey (Section 3.1)
Minimum Development Level	- As required by stormwater grading and catchment levels (Section 3.4.4)
Minimum Development Level – 1m	- Additional excavation of the minimum development level to enable placement of 1m capping of 'clean' compactable fill material
Clean Excavation Material	- Uncontaminated fill excavated during site works and suitable for reuse in the development
New Engineered Fill	- Fill material to be imported onsite to replace unsuitable excavated material
Bottom of Fill	- Maximum depth of contaminated/geotechnically unsuitable excavation based on available borehole and test pit information
Bottom of Fill + 1 m	- Depth to base of fill material + 1 m (expected maximum allowable depth for geotechnical improvement such as impact rolling)

The following key assumptions (Table 12) relating to the various scenarios were incorporated into all Site preparation design, methodology and subsequent Site preparation costing's for development works.

Table 12 Site Preparation Scenario Assumptions

SCENARIO ELEMENT	ASSUMPTION
Bulking Factor	- 1.2
Soil Density	- 1.8 tonnes/m ³
Off-site Disposal Locations	- Asbestos Contaminated Material – West Belconnen - Beneficial Re-use – West Belconnen - Contaminated Material – Mugga Tip
Imported Fill Requirements	- As per Section 6.2.3
Dewatering	- Discharge to Lake Burley Griffin • Testing regime in accordance with ACT EPA criteria for Lake Burley Griffin

A summary of the required scope of works for each Site preparation option incorporated into the AECOM opinion of cost for each Site preparation option is detailed in the following sections.

4.3.1 Site Preparation Scenarios - Option 1

Option 1 involves the excavation of the Site to the required minimum development level, the remediation of contamination hotspots and the capping of uncompacted and potentially contaminated fill areas as required.

Upon completion of excavation works, clean fill material either imported to the Site or created during excavation works, meeting both environmental and geotechnical requirements for the Site will replace areas of excavated material.

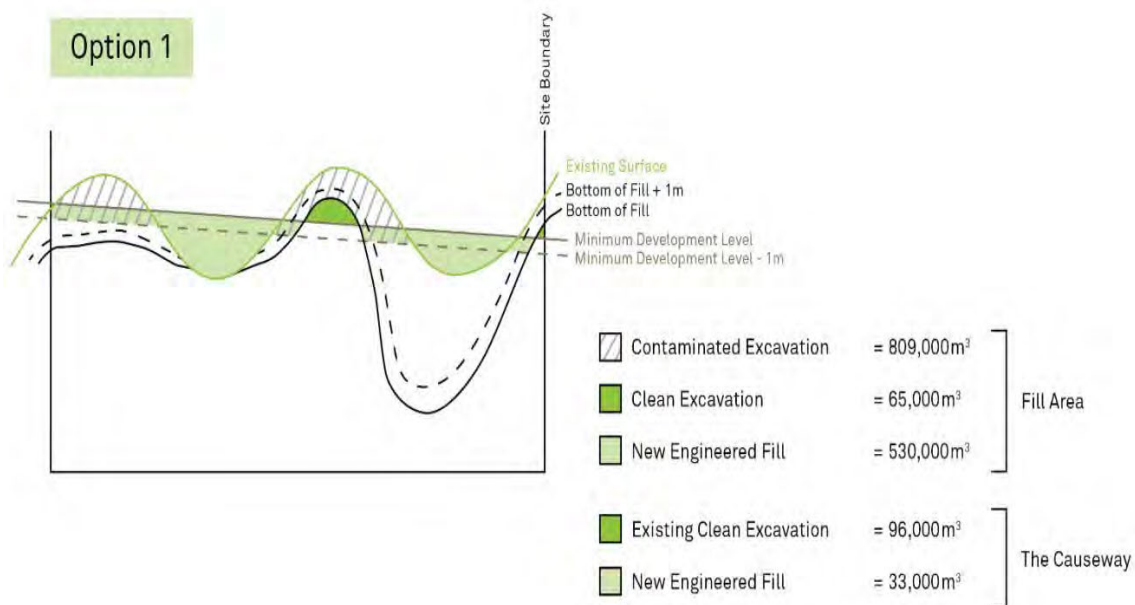
Upon completion of Site preparation works, this option will result in the remaining geotechnical and contamination issues to be addressed and managed by developers who purchase the plots located in areas containing residual fill material.

For this option AECOM has assumed the Site preparation methodology will be undertaken with the following key elements/stages:

- Preliminary works;
 - Site establishment;
 - Onsite excavation works;
 - Stockpiling of spoil;
 - Offsite disposal of contaminated waste;
 - Re-use of suitable onsite fill materials;
 - Imported fill material;
 - Levelling and grading of site; and
 - Site supervision throughout the course of the project.
- **Note: Based on calculated fill volumes, to achieve this option in one (1) year, approximately 149 20 tonne heavy vehicle trips would be required per day**

Figure 23 (below) provides a summary of the calculated excavation/capping methodology and total material volumes within Site Preparation Scenario Option 1.

Figure 23 Site Preparation Option 1 Excavation Depth and Volume



A summary of the scope of works associated with Option 1 is presented below (Table 13).

Table 13 Site Preparation Option 1

OPTION	PROPOSED SCOPE OF WORKS
Option 1 – Remediate hotspots, cap uncompacted fill. Management of general site issues undertaken by Site developers	<ul style="list-style-type: none"> - Additional Environmental Investigation Works <ul style="list-style-type: none"> • Developers to undertake due diligence assessments prior to purchase/development - Preliminary Works <ul style="list-style-type: none"> • Preparation of Detailed Remediation Action Plan • Detailed Site Survey suitable for construction purposes • Engineering Design • Preparation of Traffic Management Plan • Preparation of site specific Asbestos Management Plan for all earthworks • Preparation of Environmental Management Plans (including sediment and erosion control) • Preparation of Groundwater Management Plan and Site Dewatering Approvals • Development of Health and Safety Plans - Site Establishment <ul style="list-style-type: none"> • Site Facilities • Preparation of internal haulage roads • Sediment control • Site security • Installation of groundwater management systems - Onsite Works <ul style="list-style-type: none"> • Vegetation clearance • Excavation and onsite stockpiling of <ul style="list-style-type: none"> ▪ Approximately 809,000m³ of potentially contaminated fill material • Management of TPH hotspots • Validation sampling of hotspot removal • Classification of soil material for offsite disposal • Offsite disposal of unsuitable fill materials - Imported clean fill - approximately 65,000m³ <ul style="list-style-type: none"> • Placement of imported clean fill in compacted layers • Level and grading - Site Supervision (Approximately 12 months) <ul style="list-style-type: none"> • Project Management • Asbestos air monitoring <ul style="list-style-type: none"> ▪ Also required by developers during development works in all blocks • Environmental Validation Reporting <ul style="list-style-type: none"> ▪ Also required by developers during development works in all blocks • Ongoing Environmental Management Plan reporting <ul style="list-style-type: none"> ▪ Also required by developers during development works in all blocks • Environmental Compliance Reporting <ul style="list-style-type: none"> ▪ Also required by developers during development works in all blocks • Environmental Site Auditor <ul style="list-style-type: none"> ▪ Also required by developers during development works in all blocks

4.3.2 Site Preparation Scenarios - Option 2

Option 2 involves the full remediation of the site through the excavation of all contaminated material and the offsite disposal of unsuitable material in accordance with the methodology specified within the PB (2011) RAP. Clean fill material either imported to the Site or created during excavation works, meeting both environmental and geotechnical requirements for the Site, will replace areas of excavated material.

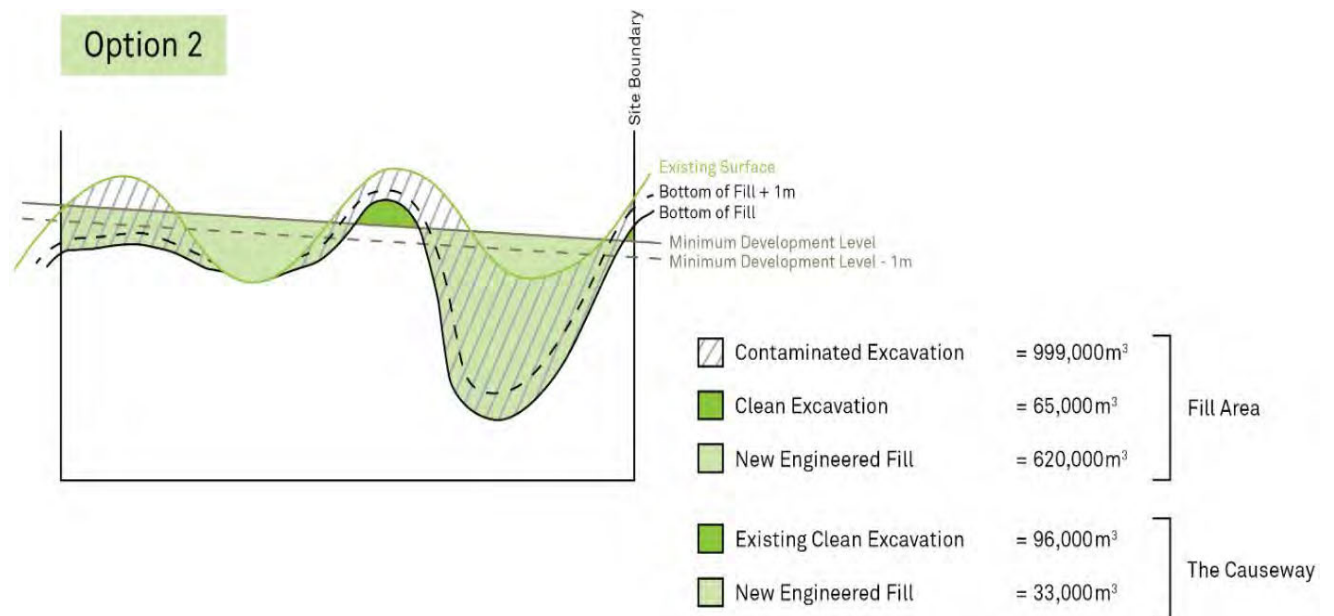
Upon completion of works, all developable sites within the Site can be sold as “suitable for the proposed land use”.

For this option we have assumed the Site preparation methodology will be undertaken with the following key elements/stages:

- Additional environmental investigation;
 - Preliminary works;
 - Site establishment;
 - Onsite excavation works;
 - Stockpiling of spoil;
 - Offsite disposal of contaminated waste;
 - Re-use of suitable onsite fill materials;
 - Importing fill material;
 - Levelling and grading of site; and
 - Site supervision throughout the course of the project.
- **Note: To achieve this option in one (1) year, approximately 183 20 tonne heavy vehicle trips would be required per day**

Figure 24 (below) provides a summary of the calculated excavation/capping methodology and total material volumes within Site Preparation Scenario 2.

Figure 24 Site Preparation Option 2 Excavation Depth and Volume



A summary of the scope of works associated with Option 2 is presented below (Table 14).

Table 14 Site Preparation Option 2

OPTION	PROPOSED SCOPE OF WORKS
Option 2 – Complete Site Remediation	<ul style="list-style-type: none"> - Environmental Investigation Works <ul style="list-style-type: none"> • Undertake additional environmental investigation to accurately determine the vertical and lateral extent of contamination within the Site and subsequent boundary of excavation works - Preliminary Works <ul style="list-style-type: none"> • Preparation of Detailed Remediation Action Plan • Detailed Site Survey suitable for construction purposes • Engineering Design • Preparation of Traffic Management Plan • Preparation of site specific Asbestos Management Plan for all earthworks • Preparation of Environmental Management Plans (including sediment and erosion control) • Preparation of Groundwater Management Plan and Site Dewatering Approvals • Development of Health and Safety Plans - Site Establishment <ul style="list-style-type: none"> • Site Facilities • Preparation of internal haulage roads • Sediment control • Site security • Installation of groundwater management systems - Onsite Works <ul style="list-style-type: none"> • Vegetation clearance • Excavation and onsite stockpiling of soil material <ul style="list-style-type: none"> ▪ Approximately 999,000 m3 of potentially contaminated fill material • Management of TPH hotspots • Validation sampling of hotspot removal • Classification of soil material for offsite disposal or reuse • Offsite disposal of unsuitable fill materials - Replacement fill <ul style="list-style-type: none"> • Placement of imported and reused clean fill in compacted layers • Level and grading - Site Supervision <ul style="list-style-type: none"> • Project Management • Asbestos air monitoring <ul style="list-style-type: none"> ▪ Required during all onsite excavation, stockpiling and onsite screening works • Environmental Validation Reporting <ul style="list-style-type: none"> ▪ Required upon completion of each separable audit boundary • Ongoing Environmental Management Plan reporting • Environmental Compliance Reporting • Environmental Site Auditor

4.3.3 Site Preparation Scenarios - Option 3

Option 3 involves the partial remediation of the Site through the excavation of fill material to a depth where impact rolling or other geotechnical ground improvement technologies may be used to improve site condition to allow development. Upon completion of works, clean fill material either imported to the Site or created during excavation works, meeting both environmental and geotechnical requirements for the Site will replace areas of excavated material.

Following a review of Site conditions and potential ground improvement technologies, it is the opinion of AECOM that fill material with a maximum thickness of 1m would be suitable for impact rolling or other ground improvement technologies to a condition suitable for development.

Where ground improvement is undertaken with areas of fill material with a thickness of greater than 1m, inadequate densification and potential void spaces with subsequent risk of sink hole development may affect subsequent development.

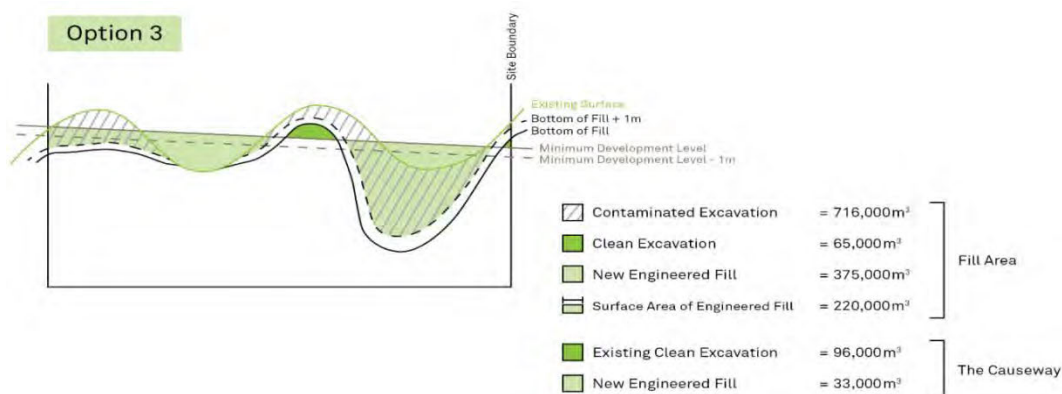
Following completion of works, residual contamination may remain within the Site at depth. Where residual contamination is identified to be potentially remaining within the Site, an ongoing Environmental Management Plan would be required to manage all ongoing risk for the life of all development

- It should be noted that the provision of ongoing environmental management plans on developable blocks would require the creation of a legally enforceable mechanism for the enforcement of provisions specified within the EMP.

For this option we have assumed the remediation methodology with the following key elements:

- Preliminary works
- Site establishment
- Onsite excavation works
- Stockpiling of spoil
- Offsite disposal of contaminated waste
- Impact rolling over excavated surface
- Re-use and compaction of suitable onsite fill materials
- Compaction of imported fill material
- Levelling and grading of site
- Site supervision throughout the course of the project
- **Note: To achieve this option in one (1) year, approximately 132 20 tonne heavy vehicle trips would be required per day**
- Figure 25 provides a summary of the calculated excavation/capping methodology and total material volumes within Site Preparation Scenario 3.

Figure 25 Site Preparation Option 3 Excavation Depth and Volume



A summary of the scope of works associated with Option 3 is presented below (Table 15).

Table 15 Site Preparation Option 3

OPTION	PROPOSED SCOPE OF WORKS
Option 3 – Partial excavation, ground improvement and capping	<ul style="list-style-type: none"> - Environmental Investigation Works <ul style="list-style-type: none"> • Undertake additional environmental investigation to accurately determine the vertical and lateral extent of contamination within the Site and subsequent boundary of excavation works - Preliminary Works <ul style="list-style-type: none"> • Preparation of Detailed Remediation Action Plan • Detailed Site Survey suitable for construction purposes • Engineering Design • Preparation of Traffic Management Plan • Preparation of site specific Asbestos Management Plan for all earthworks • Preparation of Environmental Management Plans (including sediment and erosion control) • Preparation of Groundwater Management Plan and Site Dewatering Approvals • Development of Health and Safety Plans - Site Establishment <ul style="list-style-type: none"> • Site facilities • Preparation of internal haulage roads • Sediment control • Site security • Installation of groundwater management systems - Onsite Works <ul style="list-style-type: none"> • Vegetation clearance • Excavation and onsite stockpiling of soil material <ul style="list-style-type: none"> ▪ Approximately 716,000 m³ of potentially contaminated fill material • Management of TPH hotspots • Validation sampling of hotspot removal • Classification of soil material for offsite disposal • Offsite disposal of unsuitable fill materials • Impact rolling or other ground improvement technologies <ul style="list-style-type: none"> ▪ 1 m maximum thickness of fill material - Construction of fill <ul style="list-style-type: none"> • Placement of reused and imported clean fill in compacted layers • Level and grading - Site Supervision <ul style="list-style-type: none"> • Project Management • Asbestos air monitoring <ul style="list-style-type: none"> ▪ Required during all onsite excavation, stockpiling and onsite screening works • Environmental Validation Reporting <ul style="list-style-type: none"> ▪ Required upon completion of each separable audit boundary • Ongoing Environmental Management Plan <ul style="list-style-type: none"> ▪ Required for all areas containing residual fill material • Environmental Compliance Reporting • Environmental Site Auditor

4.4 Development of Site Preparation Scenario 4

As outlined within the project objectives, AECOM developed a fourth site preparation scenario in accordance with the requirements of ESDD.

- **Option 4** - *Other options that become evident during detailed assessment of the interaction between the development staging, environmental and geotechnical requirements*

The table below provides a summary of the process involved in the development of Site Preparation Option 4. Full details are provided within Sections 4.4.1 to 4.5

Table 16 Summary of Option 4 Development

SUMMARY OF OPTION 4 DEVELOPMENT	
-	AECOM undertook consultation with key stakeholders to identify issues and potential solutions to the management of uncontrolled fill material
-	AECOM examined the cut fill balance for the Site to determine potential fill placement locations
-	Simpson and Wilson, in consultation with AECOM revised the existing draft Planning and Design Framework to incorporate a fill placement location in the South Eastern Portion of the Site in the context of identified Site contamination
-	AECOM re-assessed the storm water and minimum development levels in accordance with the revised draft PDF and calculated the revised fill excavation and placement volumes required for Site preparation.

The following sections outline the process involved within the development of Option 4.

4.4.1 Stakeholder Consultation

To define the key parameters for Option 4 and incorporate the requirements and thinking of the various stakeholders, AECOM held a workshop with the key stakeholders involved within the planning and future development of the Site.

The stakeholder workshop was held on 3 August 2012 to discuss the proposed Site development, issues and constraints and possible solutions.

Attendees included representatives from the following:

- Land Development Agency;
- Economic Development Directorate;
- Territory and Municipal Services;
- Environment and Sustainable Development Directorate; and
- Environmental Protection Authority.

The consultative stakeholder workshop began with an overview the Site conditions, a summary of works completed to date as well as the environmental considerations, geotechnical constraints and Site preparation options.

A facilitated discussion ensured that attendees were all able to provide feedback and openly discuss items of interest in alignment with the agenda.

The discussion topics and comments made by participants are outlined in Table 17 .

Table 17 Key Stakeholder Workshop Topics and Comments

TOPIC	COMMENTS
Heritage Landscaping	<ul style="list-style-type: none"> - A “walk over” could be undertaken by indigenous groups to ensure all considerations have been incorporated into the Site design. - Landscaping needs to consider potential residual contamination within the Site. Deep rooted plants may impact upon residual contamination - All maintenance costs associated with any onsite treatment systems for the first year should be built into the establishment costs. - Management plans for landscaped areas will be required prior to hand over to TAMS. - Using a predictive model might assist in longer term planning.
Water sensitive urban design	<ul style="list-style-type: none"> - The proximity of the development to Fyshwick will need to be modelled and include how potential site contamination may impact the Site development
Existing site contamination	<ul style="list-style-type: none"> - Large boulders on the Site are left over from the Parliament House construction in the late 1980s. - Builders waste material identified within the Site has a significant potential to be associated with additional asbestos material - The location for disposal of site contamination needs to be considered. The ACT Government prefers to only handle waste once. - All offsite disposal needs to consider the fact that the asbestos waste tip at West Belconnen tip is almost full. - Several regions in Australia have used capping to manage onsite contamination. - Asbestos contaminated material can be used as fill under roads although it may difficult to receive approval to do so. - Asbestos waste should be contained onsite within a controlled location as best as practicable - The Asbestos Regulators Forum will need to be advised of what option is used to dispose of the asbestos contaminated material. - Potential for the ACT Government to put memorandums on titles regarding residual low level asbestos. This has been done for the Adelaide railways development. - This would pass risk onto the developers.

TOPIC	COMMENTS
Site development	<ul style="list-style-type: none"> - The south eastern portion of the Site is currently planned to have 800 dwellings. - The plan is currently at concept stage. - The south eastern corner of the Site may be considered as a non-development area. - Not developing this area could help with stormwater and remediation issues. - The area could be utilised to place impacted fill materials
Community	<ul style="list-style-type: none"> - Although Site contamination must be remediated to a state where the Site is 'fit for purpose', there is a risk the community will consider it contaminated at any level. - This could result in contamination being a project driver. - Should even low level contamination meeting the 'fit for purpose' definition be passed onto developers? - Significant financial costs in remediating sites to standards higher than required under legislation. - There are a lot of misconceptions about asbestos and its risk in the community. - Handling perceptions about asbestos is fundamental to the success of this project. - Project will require a detailed risk communication strategy - A high level taskforce was formed for the Kingston foreshore development. This strategy could be used in the development of East Lake as well.

4.4.1.2 Key Outcomes from the Workshop

The key outcomes emerging from the stakeholder workshop included:

- Options for site contamination:
 - Pass the risk onto developers. The ACT Government could put memorandums of contamination on site titles and enforce ongoing remediation and management. This option would dramatically affect site sales prices;
 - Remove all contamination from the Site. This option was viewed as expensive and may affect the viability of the development;
 - Remediate the hot spots and cap them;
 - Manage all uncontrolled fill material onsite within a controlled location.
 - While this was the preferred option for the material, due to the volume of potentially contaminated and geotechnically unsuitable material this option was considered to be unlikely.
- The project is cost driven and therefore remediation needs to be addressed before construction.
- The community should be informed as early as possible. Therefore the development of a community engagement strategy should be prioritised.
 - The strategy may include a taskforce such as the Kingston Foreshore Development Authority.
 - It may also suggest independent technical “experts” be engaged to provide the community with information and assurance.
- Following the workshop, it is recommended that key stakeholders continue to be involved in the planning for the development of the site.
- In addition, it is recommended that the community be informed of the proposed development and engaged in a meaningful way as early as possible to mitigate the risk of community misunderstanding and outrage due to the known contamination currently existing on the Site and possible development plans.

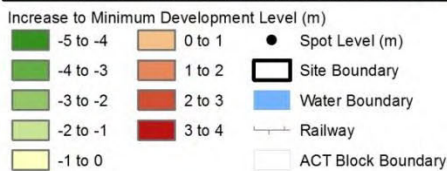
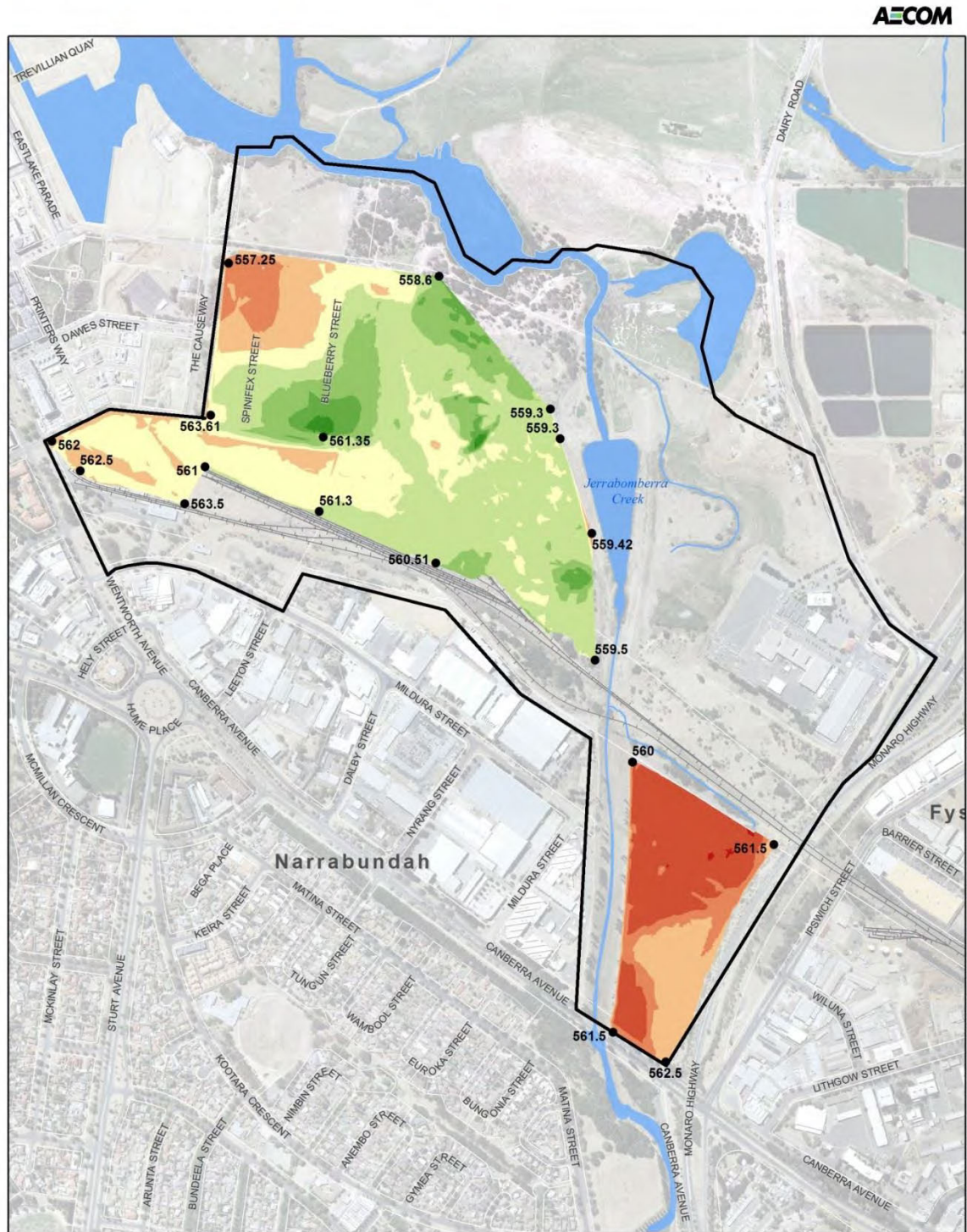
4.4.2 Development Cut/Fill Balance

Following the key stakeholder workshop, AECOM investigated the necessary cut and fill balance to create the minimum development levels and determine the potential for onsite re-use of contaminated and geotechnically unsuitable fill materials within various sections of the Site (Figure 26 and Figure27).

Following an assessment of the required cut/fill volumes within the Site to meet the minimum development levels, it was the opinion of AECOM that as the South Eastern portion of the Site required significant volumes of fill material to raise it to the required development levels (approximately 3-- 4 m), the placement of contaminated and geotechnically unsuitable material should be examined within this area.

It should also be noted that previous environmental investigations within the Site, did not identify potential site contamination within the south eastern portion of the site

Figure 26 Cut and Fill to minimum development levels



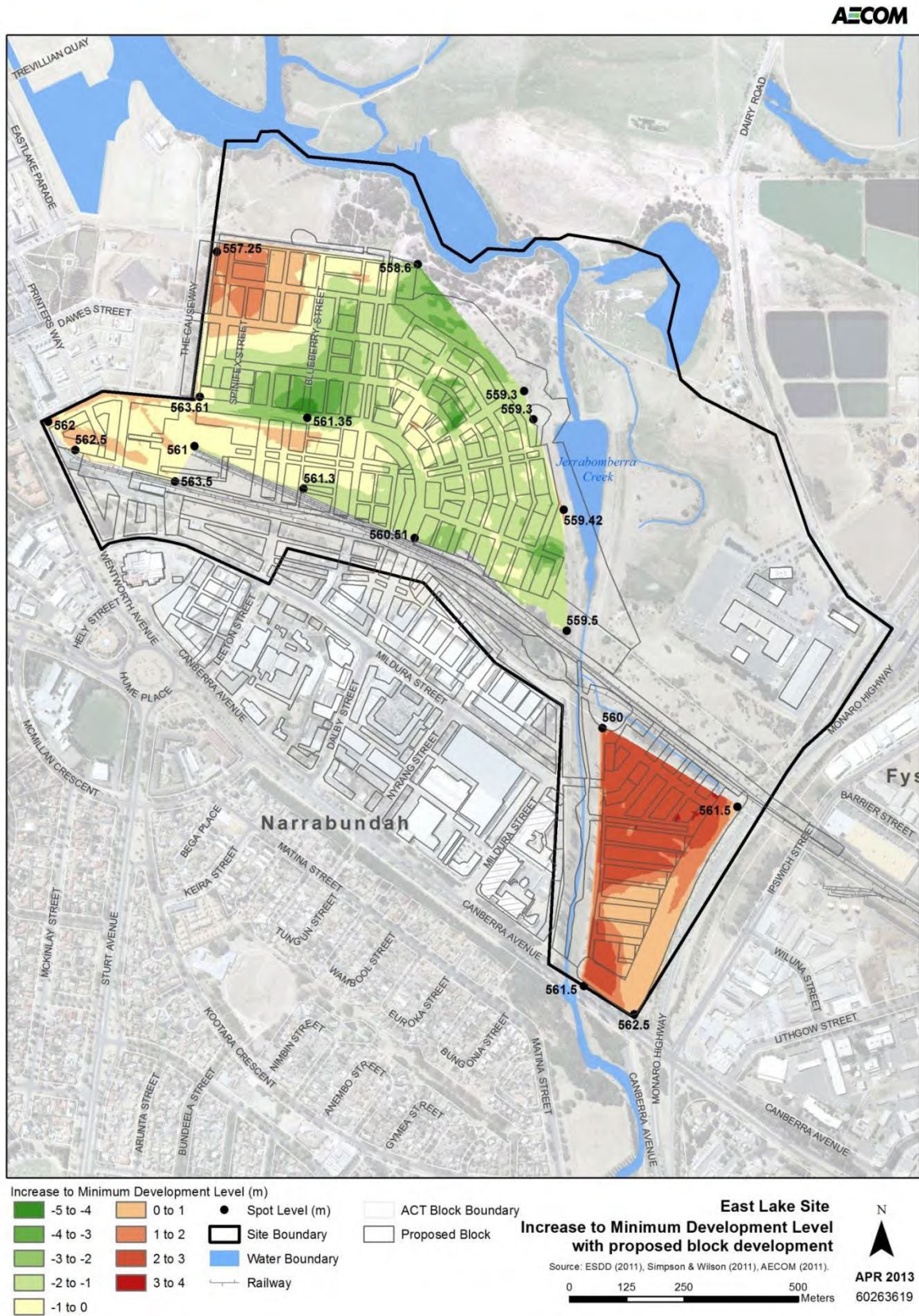
**East Lake Site
Increase to Minimum Development Level**

Source: ESDD (2011), Simpson & Wilson (2011), AECOM (2011).

0 125 250 500 Meters

N
APR 2013
60263619

Figure 27 Cut and Fill to minimum development levels with proposed site layout

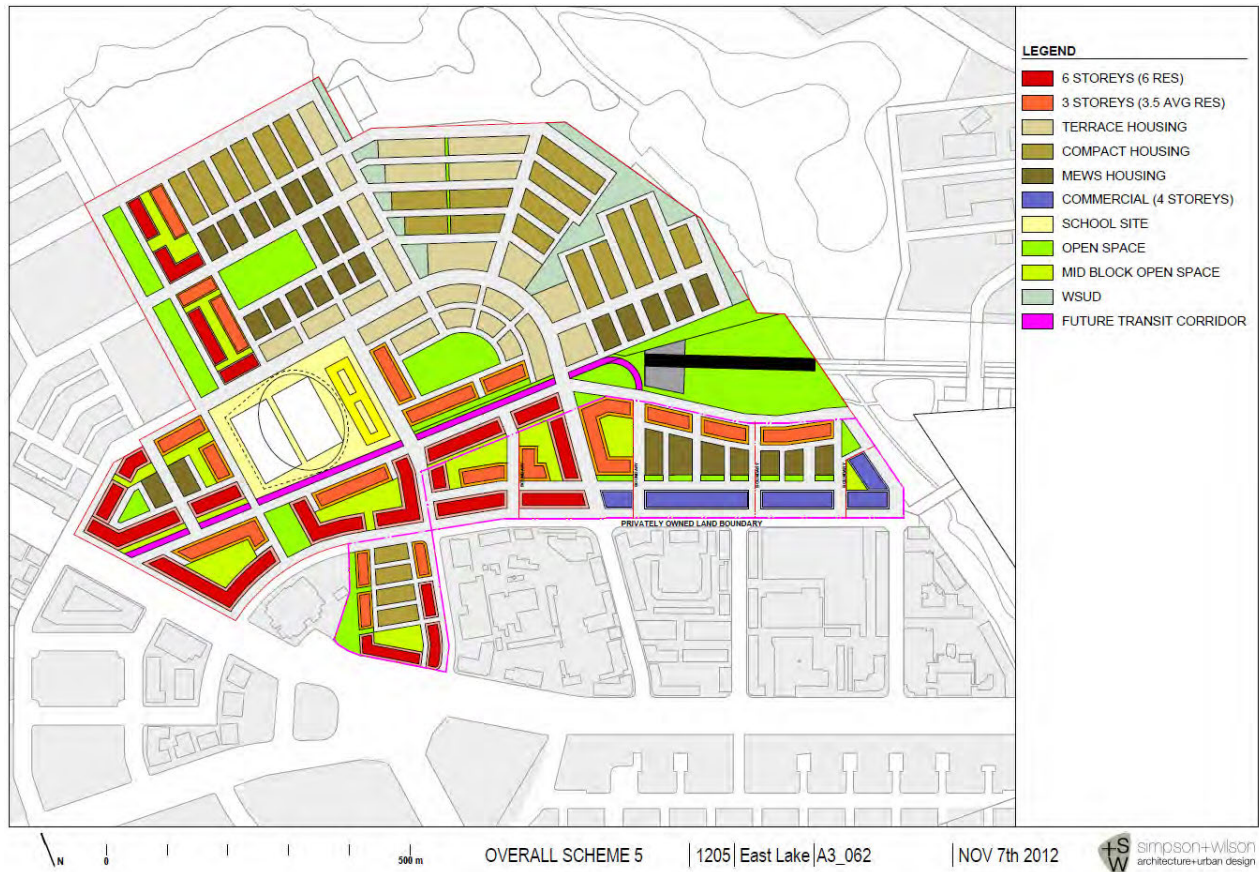


4.4.3 Revised Planning Design Framework

Following the decision that the south eastern portion should be examined as a potential placement location for unsuitable fill materials, Simpson and Wilson in consultation with AECOM revised the draft PDF to remove the south eastern portion of the Site from the developable area of the Site.

The figure below details the revised draft Planning and Design Framework (November 2012)

Figure 28 Revised Planning Design Framework (Simpson and Wilson November 2012)



4.4.4 Revised Stormwater and Flood Management Options

Stormwater drainage is the key driver to determine the minimum finished level at East Lake. Other services and urban design details may be adjusted accordingly. AECOM prepared a revised minimum development level surface to support the revised PDF. This minimum development level ensures a fully TaMS compliant stormwater network can be constructed and includes two floodways through the Site to reduce stormwater pipes lengths and more importantly lower the minimum development level as much as possible. Minimising the finished development level minimises the volume of clean fill needed to be imported. The resulting minimum development level ensures:

- All development within the Site is above the 100 year ARI flood level with adequate freeboard. As noted in Section 3.4.4.2 a 300 mm freeboard has been adopted adjacent to Jerrabomberra Creek and a 500 mm freeboard has been adopted adjacent to the Molonglo River (along the northern boundary of the Site)
- All piped stormwater infrastructure can grade at 1.0% minimum grade and discharge above the 5 year ARI peak flood level in Jerrabomberra Creek and the Molonglo River floodplain with adequate pipe cover
- Existing surface levels are generally maintained in The Causeway except in the north-west corner where levels are raised above the 100 year ARI flood level and along the south side where some regarding is required to achieve stormwater flows as noted below

- The proposed oval grades to overland flow paths located along the northern and southern boundaries of the oval. These overland flow paths exit the Site at Cunningham Street
- The areas adjacent to the proposed floodways batter towards the floodways without the need for retaining walls to facilitate a change in grade between the existing surface levels adopted in The Causeway and the lower minimum development levels adopted elsewhere in the Site. The southern and eastern extent of The Causeway will need to be regraded towards the proposed floodway to achieve this objective
- The proposed floodways are aligned with regions of significant contamination where deep excavations are already required to remove the contaminated material.

WSUD and Stormwater Quality Management

A WSUD strategy was developed for the East Lake site redevelopment and tested in MUSIC to achieve the development stormwater quality improvement targets. The strategy was kept consistent with the initial strategy for the initial draft PDF.

The following local WSUD measures were incorporated into the East Lake site MUSIC model:

- Rainwater tanks
- Street-scale bioretention pods
- Gross Pollutant Traps (GPTs)

The following assumptions were made for the WSUD measures:

- Rainwater tank volumes and reuse demands were adopted based on recommendations in the ACT Waterways WSUD General Code. The vast majority of proposed lots have an area less than 300 m² and therefore do not require to have rainwater tanks installed
- Rainwater tank high-flow bypass set to the 100 year ARI event peak flow
- Street-scale bioretention incorporated at approximately 70 m intervals along the kerb and channel of all roads
- Street-scale bioretention pods have 200 mm extended detention depth and a 20 m² typical area
- Bioretention pod high-flow bypass set to the 3 month ARI event peak flow
- Additional bioretention has been included in the proposed water spine areas within East Lake
- Gross pollutant traps were assumed to have 90% retention of gross pollutants. The retention rate for TSS, TP and TN was assumed to be 0%

Results showed that the provisions made in the revised draft PDF were not sufficient in order to meet the ACT Waterways WSUD General Code requirements as highlighted below.

Table 18 MUSIC Model Results for revised draft PDF WSUD strategy

Pollutant	Developer Pollutant Reduction Targets	Reduction Results with WUSD measures
TSS	60%	76.3%
TP	45%	41.2%
TN	40%	46%

Further provisions in order to meet ACT Waterways WSUD General Code Developer Targets

Additional WSUD measures and provisions are required in order for the project to be compliant with the relevant stormwater quality improvement requirements.

The MUSIC modelling undertaken showed that additional bioretention provisions of 500m² for catchments C and D would be sufficient to meet the “developer” targets:

The revised stormwater quality improvement results are shown below.

Table 19 MUSIC Model Results for proposed Developer treatment measures

POLLUTANT	DEVELOPER POLLUTANT REDUCTION TARGETS	REDUCTION RESULTS WITH PROPOSED MEASURES
TSS	60%	82%
TP	45%	45%
TN	40%	52%

The limiting parameter is Phosphorus. Consequently the performance for the other water quality parameters far exceeds the necessary minimum levels.

Potential for regional measures in order to comply with the ACT Waterways WSUD General Code Regional Targets

In order to meet Regional stormwater quality improvement targets “end of line” wetlands to treat catchments B, C, D and G downstream of the urban treatment train. It should be noted that requirements relating to the end of line wetlands within area G are subject to the AECOM Fyshwick Stormwater Treatment report.

The following assumptions were made in regards to the proposed wetlands:

Table 20 Preliminary Regional Wetland Parameters

WETLAND PARAMETERS	CATCHMENT			
	B	C	D	G
Inlet basin surface area (% of wetland surface area)	10.0%	10.0%	10.0%	10.0%
Inlet basin surface area (m ²)	380	410	620	870
Wetland surface area (as % of catchment)	4.0%	4.0%	4.0%	4.0%
Wetland surface area (m ²)	3,800	4,100	6,200	8,700
EDD	0.5	0.5	0.5	0.5
Permanent Pool volume (m ³)	1,150	1,220	1,870	2,600
Notional Detention Time	~ 72 hrs	~ 72 hrs	~ 72 hrs	~ 72 hrs

The expected performance of the proposed integrated developer and regional measures was modelled in MUSIC. Results are show below.

Table 21 MUSIC Model Results for proposed “Developer” and “Regional” treatment measures

POLLUTANT	DEVELOPER POLLUTANT REDUCTION TARGETS	REDUCTION RESULTS WITH PROPOSED MEASURES
TSS	85%	90%
TP	70%	71%
TN	60%	66%

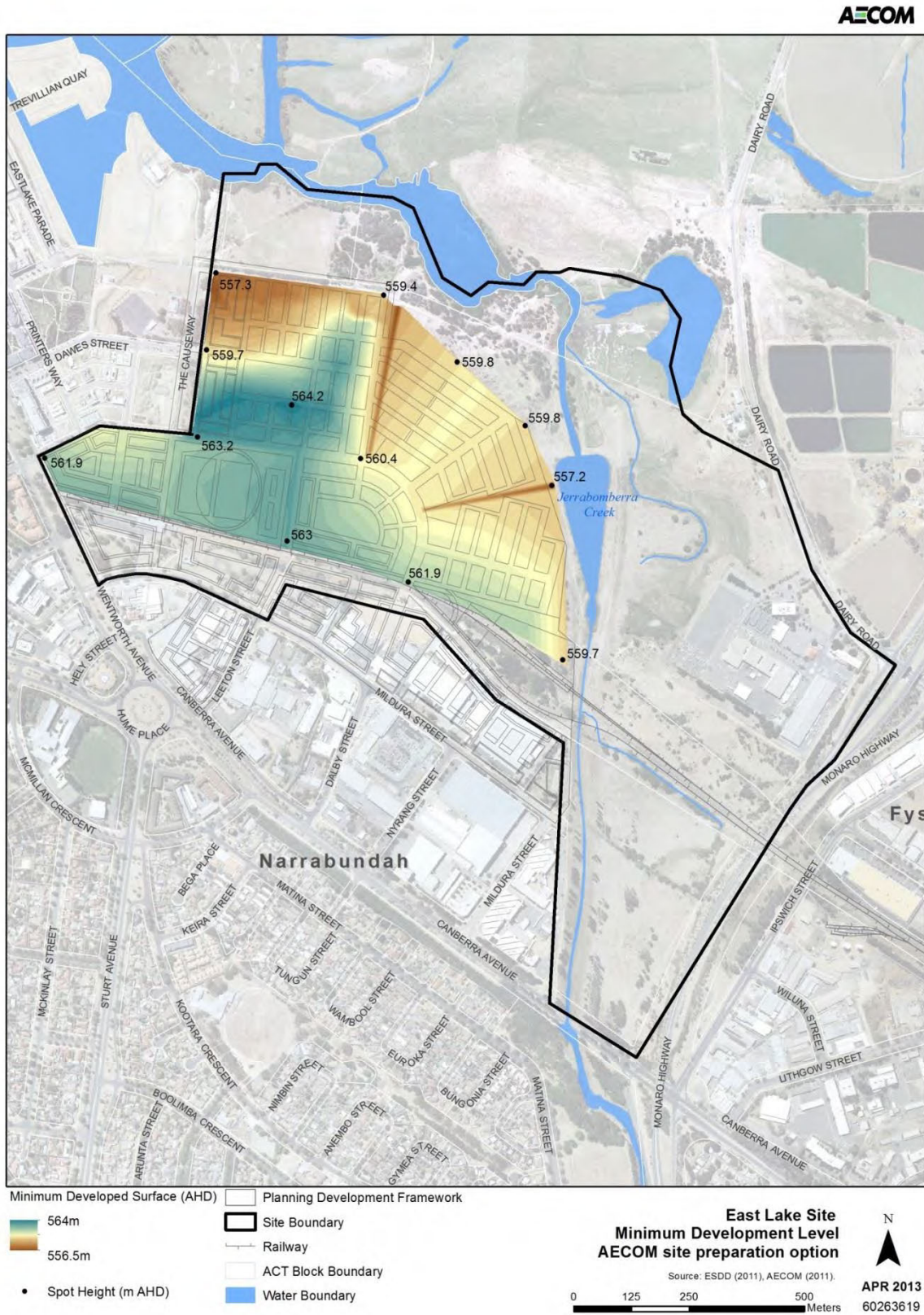
4.4.5 Revised Required Development Levels

The revised minimum development level was determined based on the flooding and stormwater constraints identified in Section 3.4.4.

It is noted that the minimum development level is lower than the existing surface level across the majority of the Site, excluding The Causeway where existing surface levels have been adopted where possible.

The revised minimum development level map is presented in Figure 29 .

Figure 29 Revised Minimum Development Levels – November 2012 PDF



4.5 Site Preparation Scenario - Option 4

Option 4 involves the excavation of clean fill material from the South Eastern portion of the Site and excavation of contaminated and geotechnically unsuitable fill material from the central portion of the Site.

Contaminated and geotechnically unsuitable fill material is transported and placed within the South Eastern portion of the Site where upon completion of the excavation it is capped with a 1 m thick layer of clean fill material to the required development level.

Clean fill material excavated from the South Eastern portion of the Site; meeting both environmental and geotechnical requirements for onsite beneficial re-use will replace areas of excavated material.

Full details of the proposed development staging for Option 4 is presented within Section 6.0.

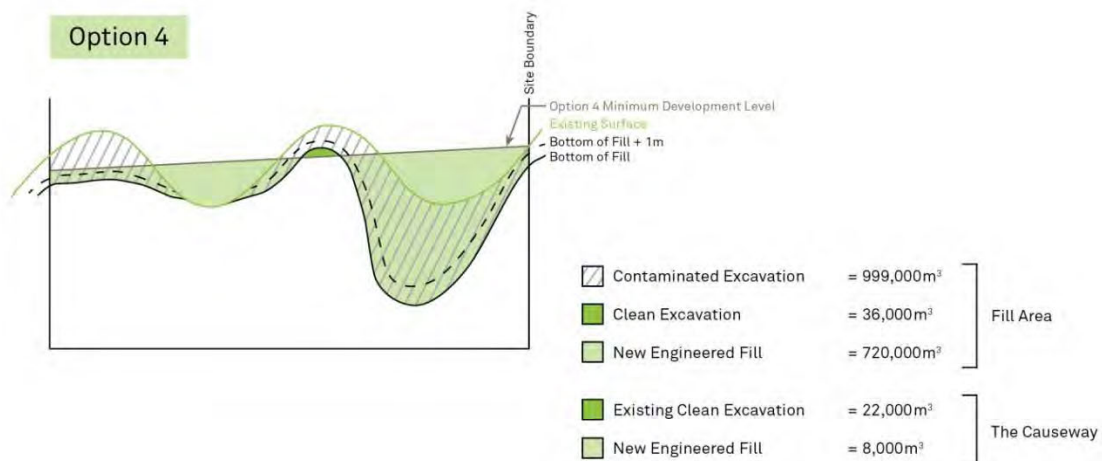
Upon completion of works, all developable sites within the Site can be sold as 'suitable for the proposed land use'.

For this option we have assumed the remediation methodology with the following key elements:

- Preliminary works
- Site establishment
- Excavation of clean fill from the south eastern portion of the Site
 - Transporting of clean soil to be used as fill for main site using conveyor belt system to stockpile adjacent to main site
- Onsite excavation works
- Stockpiling and screening of potentially contaminated spoil
- Onsite placement of contaminated waste within south eastern portion of the Site
 - Transporting of stockpiled contaminated soil from main site using conveyor belt system
- Re-use of onsite fill materials where possible
- Offsite disposal of unsuitable material where necessary
- Levelling and grading of Site
- Site supervision throughout the course of the project
 - Note: AECOM has assumed transport rate of up to 3300 tonnes of material per hour via the conveyor belt systems. These would be fully enclosed and facilitate water spraying to provide dust control.

Figure 30 (below) provides a summary of the calculated excavation/capping methodology and total material volumes within Site Preparation Scenario Option 1.

Figure 30 Site Preparation Option 4 Excavation Depth and Volume



A summary of the scope of works associated with Option 4 is presented below (Table 22).

Table 22 Site Preparation Option 4

OPTION	PROPOSED SCOPE OF WORKS
Option 4 – Onsite encapsulation of impacted fill material	<ul style="list-style-type: none"> - Preliminary Works <ul style="list-style-type: none"> • Preparation of Detailed Remediation Action Plan/Strategy • Detailed Site Survey • Engineering Design • Preparation of Traffic Management Plan • Preparation of site specific Asbestos Management Plan for all earthworks • Preparation of Environmental Management Plans (including sediment and erosion control) • Preparation of Groundwater Management Plan and Site Dewatering Approvals • Development of Health and Safety Plans - Site Establishment <ul style="list-style-type: none"> • Site Facilities • Preparation of internal haulage roads • Sediment control • Site security • Installation of groundwater management systems • Construction of conveyor system to south east portion of the Site - Onsite Works <ul style="list-style-type: none"> • Vegetation clearance • Management of TPH hotspots • Validation sampling of hotspot removal • Excavation of clean fill <ul style="list-style-type: none"> ▪ Clean fill to be excavated from south eastern portion of the Site in a staged approach consistent with the timing and volume of impacted material • Excavation of impacted soil material <ul style="list-style-type: none"> ▪ Approximately 999,000 m3 of potentially contaminated fill material • Onsite screening/sorting of fill material <ul style="list-style-type: none"> ▪ Fill to be classified onsite within designated screening locations ▪ Material requiring offsite disposal to be placed in temporary location prior to disposal • Placement of asbestos contaminated material (ACM) impacted fill material within designated location in south eastern portion of the Site - Site Supervision <ul style="list-style-type: none"> • Project Management • Asbestos air monitoring <ul style="list-style-type: none"> ▪ Required during all onsite excavation, stockpiling and onsite screening works • Environmental Validation Reporting <ul style="list-style-type: none"> ▪ Required upon completion of each separable audit boundary • Ongoing Environmental Management Plan <ul style="list-style-type: none"> ▪ Required for all areas containing residual fill material • Environmental Compliance Reporting • Environmental Site Auditor

5

EAST LAKE URBAN RENEWAL SITE PREPARATION OPTIONS ANALYSIS

EAST LAKE SITE PREPARATION FEASIBILITY STUDY

5.0 East Lake Urban Renewal Site Preparation Options Analysis

5.1 Paired Analysis Comparison

To enable assessment of the advantages and disadvantages of the various site preparation scenarios, AECOM undertook a paired analysis of the key contributing factors to the success of the East Lake Urban Renewal Site project (Table 23).

The key success factors were identified as follows:

- Technical Suitability;
- Financial Cost;
- Logistical Suitability;
- Timing;
- Resource Use (RU);
- Waste Generation (WG);
- Material Reusability (MR);
- CO2 Generation (CO2);
- Community Impact (CI); and
- Ongoing Management and Risk (OGM).

The weighting applied to the various categories and factors in the options analysis was undertaken utilising paired comparison analysis (PCA). PCA allows for the determination the importance of a number of criteria relative to each other.

The process for deriving the respective weighting for each success factor within this assessment is relatively simple and is shown in Table 23. In each cell, a criterion in a row is compared with a criterion in a column. For each cell, it is decided which of the two criteria is more important (it should be noted that this assessment is subjective). If both criteria are deemed to be of equal importance, then they are ranked equally.

Following the comparison of all criteria against one another, the number of times the criteria was deemed 'more important' or 'of equal importance' is divided by the total number of comparisons to provide a factor score and weighting.

Table 23 Project Success Factors Paired Analysis Comparison

Key Success Factor											Factor Score	Weighting	
	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10			
1.1 Technical		1	1	1	1	1	1	1	1	1	1	9	20%
1.2 Financial	0		1	1	1	1	1	1	1	1	1	8	17%
1.3 Logistical	0	0		1	1	1	1	1	1	1	1	7	15%
1.4 Timing	0	0	0		1	1	1	1	1	1	1	6	13%
1.5 RU	0	0	0	0		1	1	1	1	0	0	4	9%
1.6 WG	0	0	0	0	0		1	1	1	1	1	4	9%
1.7 MR	0	0	0	0	0	0		1	1	0	0	2	4%
1.8 CO2	0	0	0	0	0	0	0		0	1	1	1	2%
1.9 CI	0	0	0	0	0	0	0	1		1	1	2	4%
1.10 OGM	0	0	0	0	1	0	1	1	0		1	3	7%
												46	100%

5.2 Options Analysis

The weighting derived from the paired comparison applied to the options analysis for each of the pre-determined success factors was as follows

- Technical – 20%
- Financial - 17%
- Logistical – 15%
- Timing – 13%
- Resource Use (RU) – 9%
- Waste Generation (WG) – 9%
- Material Reusability (MR) – 4%
- CO2 Generation (CO2) – 2%
- Community Impact (CI) – 4%
- Ongoing Management and Risk (OGM) – 7%

Following analysis of the above paired comparisons the derived weightings were used to assess the suitability of each site preparation scenario for meeting the success factors assigned to the project.

Each success factor is assigned a score of between 1 and 5, with 1 being the lowest likelihood of achieving the project success factor and 5 being the highest likelihood.

The following table (Table 24) outlines the analysis of assessed suitability for each of the Site Preparation Options detailed above in the context of key success factors.

Table 24 Site Preparation Options Analysis

Site Preparation Option	Option Description	Feasibility				Sustainability						Comments	Weighted Total Score
		Technical	Financial	Logistical	Timing	RU	WG	MR	CO2	CI	OGM		
		20%	17%	15%	13%	9%	9%	4%	2%	4%	7%		
Option 1	Clean environmental hotspots, cap uncompacted fill area as required. Management of general geotechnical and environmental issues would be managed by individual Site developers	4	3	1	4	4	3	2	3	2	1	<ul style="list-style-type: none"> - Technically feasible - Minimal upfront cost to ACT Government - Logistical issues associated with remediating the Site up to block boundaries due to excavation depths - Ongoing risk passed on to developers would significantly affect property prices. - Community reaction to residual contamination not expected to be favourable. - High chance for ongoing cost to ACT Government. - Significant risk of ongoing remediation adjacent to residential blocks. - Very little chance of high re-use volumes of material 	2.9

Site Preparation Option	Option Description	Feasibility										Sustainability	Comments	Weighted Total Score
		Technical	Financial	Logistical	Timing	RU	WG	MR	CO2	CI	OGM			
		20%	17%	15%	13%	9%	9%	4%	2%	4%	7%			
Option 2	Remediate the whole of the fill for geotechnical and environmental contamination by excavation, removal of unsuitable materials and replacement of the soil materials as controlled fill	4	1	3	1	2	1	1	1	5	1	-	Technically feasible - Significant cost associated with works - Potential for higher quantities of contaminated material than expected - High truck movement numbers could create traffic concerns on tip route - Little beneficial re-use potential within the Site due to required development levels - Site will not require an ongoing EMP for management of residual impact	2.2
Option 3	Clean environmental hotspots and use partial excavation in conjunction with ground improvement such as impact rolling to improve the geotechnical properties of the Site followed by adequate controlled fill capping	4	2	1	2	1	2	2	2	2	2	-	Efficacy of ground improvement technologies is dependent on soil properties - Not expected to improve greater than 1 m of fill. - Significant costs associated with fill improvement - Potential health and safety implications with impact rolling potential ACM material - Site will require an ongoing EMP for management of residual impact - Significant volume of fill material would still require	2.2

Site Preparation Option	Option Description	Feasibility				Sustainability						Comments	Weighted Total Score
		Technical	Financial	Logistical	Timing	RU	WG	MR	CO2	CI	OGM		
		20%	17%	15%	13%	9%	9%	4%	2%	4%	7%		
												excavation and disposal	
Option 4	Full Site remediation and in-situ encapsulation of impacted fill material	4	3	4	4	4	5	5	4	4	5	- Technically feasible - Revised Site levels enable onsite re-use of materials with south eastern portion of the Site - ACT Government would retain control of site preparation works and ensure its remediation was undertaken correctly - Fill material placement is in accordance with ACT waste disposal hierarchy - Potential for no offsite disposal - Potentially most cost effective option - Allows for a greater level of uncertainty within contaminated material volumes	4.0

Note: RU - Resource Use, WG - Waste Generation, MR - Material Reusability, CO2 - CO2 Generation, C I- Community Impact, OGM - Ongoing Management and Risk

Following completion of the remediation options analysis in accordance with the project success factor weightings derived within the paired analysis, the remediation options were ranked in the following order of the likelihood of achieving the key project success factors as follows:

- 1) Option 4 – Total weighted score of 4
- 2) Option 1 – Total weighted score of 2.9
- 3) Option 2 and Option 3 – Total Weighted score of 2.2

6

EAST LAKE URBAN RENEWAL STAGING STRATEGY

EAST LAKE SITE PREPARATION FEASIBILITY STUDY

6.0 East Lake Urban Renewal Staging Strategy

6.1 Introduction and Overview

Following information provided by ESDD, for the purposes of the development staging strategy, AECOM has proposed the development be undertaken in three distinct phases, linked to the distribution of geotechnical and environmental contaminants, as follows (Figure 31):

- Phase 1 – Redevelopment of The Causeway located within the north eastern portion of the Site;
- Phase 2 – Development of the Central portion of the Site; and
- Phase 3-- Development of the southern portion of the Site within the vicinity of the existing railway infrastructure.

It is the opinion of AECOM that to ensure a streamlined approvals process, the three key stages should form the basis for Site Audit boundaries for environmental assessment, remediation and validation works.

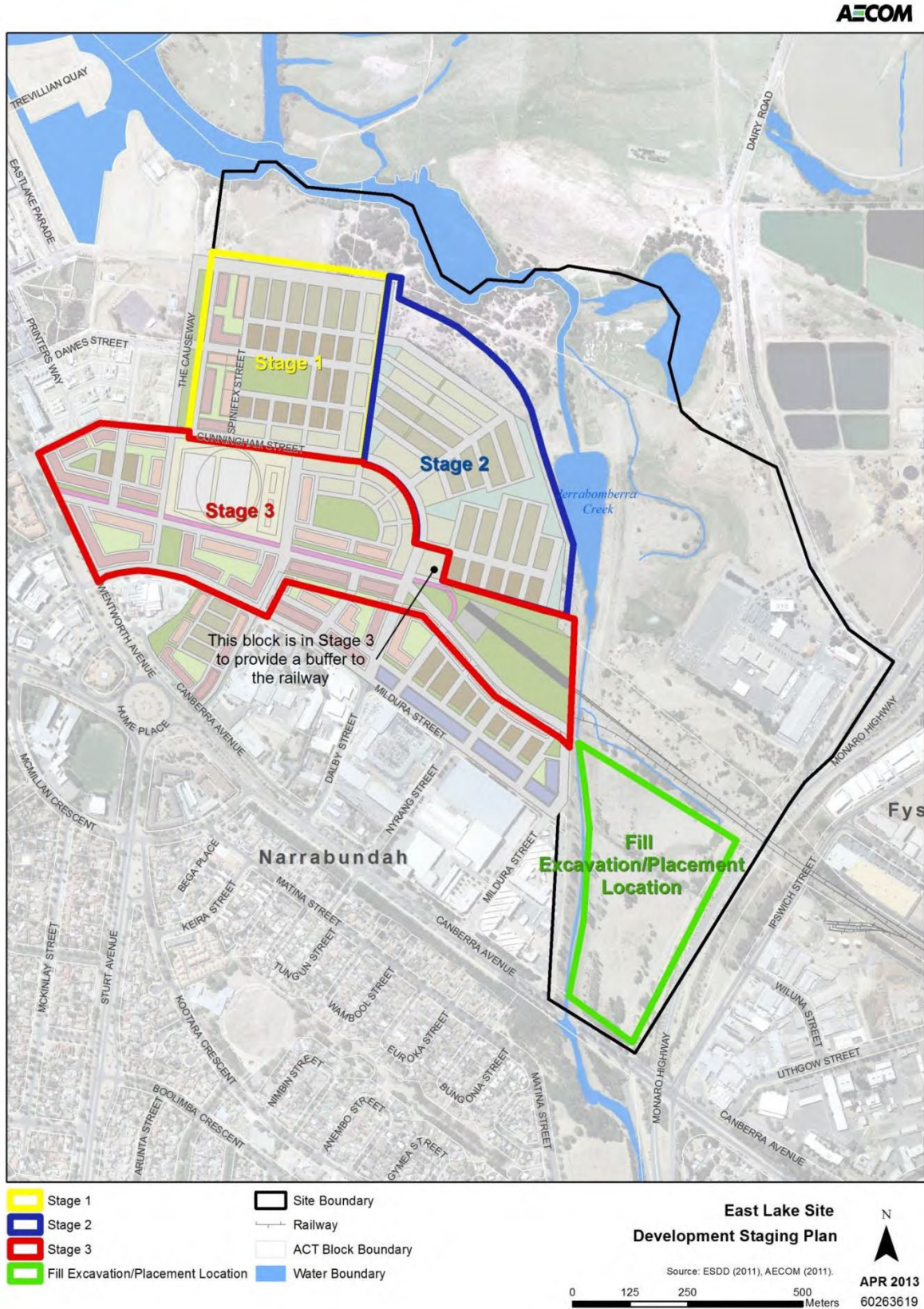
The staged site preparation approach has been identified to have the following key benefits:

- Allow the ACT Government to stage its Land Release Program;
- Offset remediation costs through staged development;
- Provide the required space to undertake remediation activities associated with uncontrolled fill material; and
- Minimise the risks associated with development being undertaken in close proximity to Site remediation works.

The approach would consist of the various stages:

- Pre-construction management requirements;
 - Establishment of an East Lake Development Management entity (governance form yet to be identified) is strongly recommended
 - Project risk communication to general public and key project stakeholders
 - Imported fill specification
 - Site dewatering approvals
 - Preparation of Site Asbestos Management Plan for all future earthworks (post Site preparation)
- Preliminaries and approvals;
 - Preparation of detailed Remediation Action Plan/Strategy
 - Detailed Site survey to enable construction level detail
 - Engineering Design
 - Preparation of Traffic Management Plan
 - Preparation of Environmental Management Plans (including sediment and erosion control)
 - Development of Health and Safety Plans
- Site Preparation;
 - Development Stage 1
 - Development Stage 2
 - Development Stage 3
 - Development Stage 4

Figure 31 Development Staging Plan – Phases of Development



6.2 Pre-Construction Management Requirements

Following a review of development projects with similar site constraints to the East Lake development project, the following Pre-Construction management approaches are recommended to provide a mechanism for ensuring successful outcomes and managing potential community concerns.

6.2.1 Establishment of a Development Management entity

Key to the success of the East Lake development is an understanding of the processes undertaken to enable development and the requirements associated with those processes (e.g. Site Audit Statements).

The primary objective of the East Lake Development Management entity would be to provide a centralised and consistent working group for the management of issues that arise during Site development works.

A consistent management entity would enable decisions regarding future modifications to the site boundaries etc. to be made in the context of the overall planning for the Site and ensure that any decisions made do not affect the overall delivery of the Site.

The management entity would also be key in providing direction in the following areas:

- Media consultation;
- Community consultation;
- Risk mitigation associated with development strategies;
- Development of strategic direction in relation to land release;
- Oversight of change management to ensure future decisions consider all potential implications;
- Evaluation of the effectiveness of outcomes; and
- Identifying opportunities for improvement.

6.2.2 Project Risk Communication

Development within a 'brownfield site' has a number of potential issues to contend with; not least of all is public perception on the risk associated with historical contamination.

Residual site contamination is often associated with a range of environmental factors and is of great concern to building occupants, visitors and other vested stakeholders. In a mixed commercial and residential suburb such as East Lake, where substantial subsurface contamination issues are present, these concerns are often magnified and regulators expect to encounter questions from concerned residents such as:

- Is the air that our children breathe in our home safe; and
- What effect will this contamination have on our property value?

These concerns can become a 'hot button' issue that can affect the potential economic development of a suburb and drive regulating authorities to institute a number of measures to ensure issues are dealt with appropriately.

To effectively manage these issues, it is considered critical that a Project Risk Communication Plan be developed that presents the following details in an honest and open account of the site.

- 1) The site was historically contaminated and will never be 'greenfield site';
- 2) The site contamination was remediated and managed in accordance with best practice technologies and independently audited and verified by qualified scientists in the field of site contamination;
- 3) Residual risks with the Site remain;
- 4) The process for management of the residual risks;
- 5) Detail the residual risk to occupants and Site users; and
- 6) Provide a mechanism for obtaining further information.

By effectively and proactively managing public perception to the risks associated with the Site, future occurrences or finds of unexpected contamination can be managed in an efficient and scientifically robust manner with the full co-operation of the public.

6.2.3 Imported Fill Specification

The aim of this specification is to provide guidance on allowable fill material to be imported to the Site. Careful selection and use of fill material is essential in meeting environmental compliance and subsequent construction staging programs proposed within this report.

Due to the nature of existing fill materials within the Site, it is critical to the successful development of East Lake that all imported fill material is carefully screened and subject to an approvals process. Adherence to this specification will assist in ensuring that contaminated material or geotechnically unsuitable material is not imported to the Site thereby affecting the ongoing staging of works and compliance activities within the Site.

Any deviation from the outlined specifications may result in the excavation and removal of fill materials or further in-situ assessment and ACT EPA review and/or approval, resulting also in time delays.

These specifications should include the following key requirements:

- Definition of fill materials;
- Environmental requirements;
- Geotechnical requirements; and
- Approvals and Regulatory Requirements.

6.2.4 Site Dewatering Approvals

Due to potential for encountering groundwater during excavation works within the Site, a detailed plan should be developed to manage all water within the Site requiring disposal.

As trucking and offsite disposal of extracted water would be costly for the development, a dewatering management plan should be developed that details the process and procedures required for discharge of water to the nearby Lake Burley Griffin.

In developing the staging plan, AECOM has assumed that a single discharge permit would be granted for the Site, with regular testing and monitoring to be undertaken in accordance with ACT EPA requirements.

To assess the suitability of groundwater within the Site for disposal within Lake Burly Griffin, the ACT EPA has produced a set of assessment criteria. The ACT EPA assessment criteria are presented below within Table 25.

In addition to monitoring, management procedures such as sedimentation tanks, pH balancing etc. must be adopted to ensure the quality of water entering Lake Burley Griffin is maintained.

Table 25 ACT EPA Lake Burley Griffin disposal criteria

ANALYTE	ACCEPTABLE CONCENTRATION
Turbidity	< 60 NTU
pH	6.5 - 9
Electrical Conductivity	<500 uS/cm
Fluoride	< 1,500 ug/L
Oil and Grease	not visible
Dissolved Oxygen	< 4 mg/L
Suspended Solids	< 50 mg/L
Arsenic	< 50 ug/L
Cadmium	< 0.2 ug/L
Chromium	< 4 ug/L
Copper	< 4 ug/L
Lead	< 2 ug/L
Mercury	< 0.1 ug/L
Nickel	< 25 ug/L
PAH	< 3 ug/L
Zinc	< 25 ug/L
TPH	< 600 ug/L
TBT	< 0.008 ug/L
Benzene	< 300 ug/L
Ethylbenzene	< 140 ug/L
Tolulene	< 300 ug/L
Xylene	< 380 ug/L

6.2.5 Preliminaries and Approvals

Prior to the establishment of the Site, all plans, programs, licences and other documents necessary for the commencement of works will require completion. These documents should include (but not be limited to) the following:

- Detailed Site Survey
 - A detailed survey of the Site is to be undertaken prior to the commencement of works to ensure all levels pre and post site preparation are accurate and meet the requirements for future development.
 - The detailed survey will be incorporated into subsequent engineering reports and remediation action plans prepared for the Site
- Preparation of Detailed Remediation Action Plan/Strategy
 - A Remediation Action Plan is to be prepared for the Site that details the process and procedures to be followed to enable the Site to be suitable for the proposed land use
 - The Remediation Action Plan must be approved by both an independent site auditor and the ACT EPA prior to commencement of works

- Engineering Design for excavation and placement activities
 - Prior to the commencement of excavation works within the Site, a detailed engineering design for all works is to be undertaken to ensure all excavation and placement areas have been designed in accordance with relevant standards. This will include all requirements for dewatering, shoring and other technologies to ensure Site stabilisation as well as compaction standards and Quality Assurance requirements.
- Preparation of Traffic Management Plan
 - A detailed traffic management plan is to be prepared prior to works commencing to provide specifications on required routes to land fill, access and exit points within the Site, allowable transport times
- Preparation of Environmental Management Plans (including sediment and erosion control)
 - An Environmental Management Plan is to be developed prior to the commencement of works. The Environmental Management Plan is to be prepared in accordance with industry best practice standards and must comply with all relevant ACT EPA regulatory guideline criteria relating to contaminated sites.
 - The plan must be reviewed by an accredited contaminated sites auditor prior to the commencement of works:
- Development of Health and Safety Plans
 - Prior to works within the Site, a detailed Health and Safety Plan (HASP) and Safe Work Method Statement (SWMS) must be produced that specifies at a minimum (but not limited to):
 - Exposure route pathway mitigation measures;
 - PPE requirements including required respiratory protection;
 - Training requirements;
 - Site signage requirements;
 - Site security;
 - Air monitoring procedures
 - Recording of elevated fibre and/or vapour levels;
 - Heat/cold stress;
 - Vehicle/machinery/plant safety; and
 - General Site safety.

6.3 Remediation Option 4 - Development Stage 1

The process for Development Stage 1 is detailed below and illustrated on Figure 32.

Clean Fill Excavation Location

- 1) Clearance of surface vegetation within required excavation area only;
- 2) Installation of sediment and erosion controls around perimeter of clean fill excavation location; and
- 3) Commencement of 'clean fill' excavation works within the south eastern portion of the Site.
 - a. Excavation works are to be undertaken to maximise the vertical extent and minimise the lateral extent of excavation as far as practicable
 - b. Excavation plans will need to allow for variations in the quantity of clean fill required while managing variable rates of placement of contaminated fill.

The Causeway Residential Site

- 1) Demolition of existing residential dwellings within The Causeway;
 - a. Removal of existing redundant infrastructure
 - b. Protection of heritage items
 - c. Removal and disposal of residual surface contamination
 - d. Removal and disposal of potential ACM constructed utility lines
 - e. Completion of required environmental clearances and Site Audit Statements
- 2) Level and grade The Causeway site to required surface level;
- 3) Clean fill material excavated from south eastern portion of the Site to be transported to The Causeway for filling to required surface level;
- 4) Compaction of imported material to allow development; and
- 5) Construction of roads and upgrades of required services/utilities.

6.4 Remediation Option 4 - Development Stage 2

The process for Development Stage 2 is detailed below and illustrated on Figure 33.

Causeway Residential Site

- 1) Sale of blocks to private developers; and
- 2) Commencement of development works in accordance with required environmental management plans

Clean Fill Excavation Location

- 1) Clearance of surface vegetation within required excavation area only; Continuation of 'clean fill' excavation works within the south eastern portion of the Site
 - a. Excavation works are to be undertaken to maximise the vertical extent and minimise the lateral extent of excavation as far as practicable
 - b. Excavation works are to be staged to ensure adequate space is created for the placement of impacted fill material, while not creating an excessive surplus of clean fill material.

Stage 2 Area Development Area

- 1) Clearance of surface vegetation;
- 2) Installation of sediment and erosion control measures;
- 3) Installation of Site dewatering measures;
- 4) Excavation and onsite screening/inspection of fill material in accordance with the Site auditor and ACT EPA approved Remediation Action Plan/Strategy;
 - a. Material identified to be ACM impacted to be transported directly to fill placement location
 - b. Material identified as potentially requiring offsite disposal transported to stockpile location 1
 - c. Material identified as potentially clean material transported to stockpile location 2
 - d. Material identified as potentially containing ACM material transported to stockpile location 3
- 5) Upon completion of excavation works (complete or staged approach) backfilling and compaction of excavation area with clean fill
 - a. Clean fill material to be sourced from stage 2 excavation area and clean fill excavation location only

Stockpile Area 1

- 1) Material identified as potentially requiring offsite disposal is to be transported to stockpile location 1
 - a. Stockpile location 1 was selected due to the proximity to connective roadways and Site access points
- 2) Material is to be stockpiled on Site and spread out and inspected/sampled in accordance with the requirements specified within the Site Auditor and ACT EPA approved RAP
- 3) Where laboratory analysis indicates the material is free from contamination the material is to be re-used as clean fill within the Stage 2 excavation area
- 4) Where ACM is identified, the material is to be transported to the fill placement location
- 5) Where contamination is identified requiring the material to be disposed offsite, the material is to be transported to a licensed land fill facility in accordance with the requirements specified within the Site Auditor and ACT approved RAP.

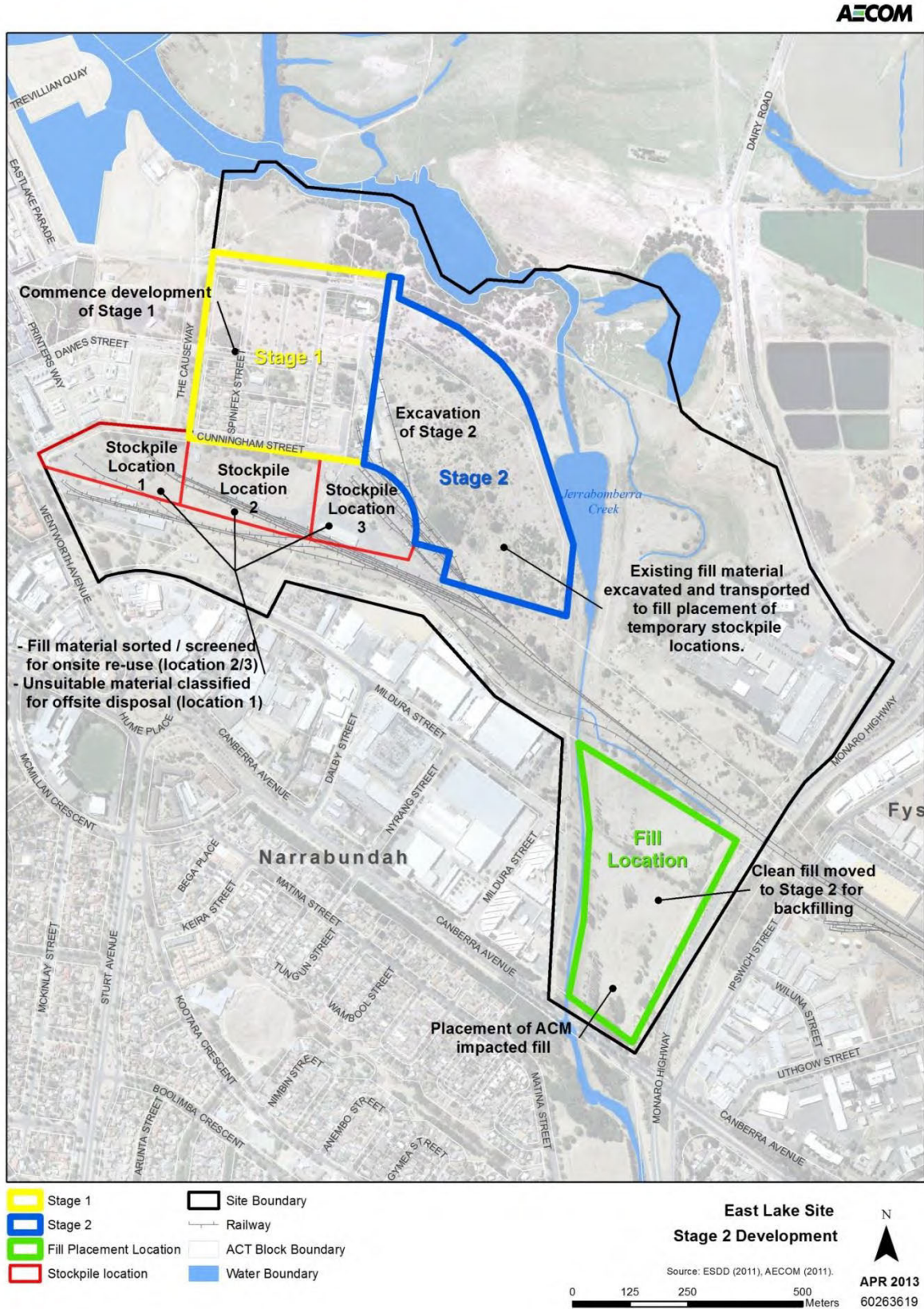
Stockpile Area 2

- 1) Material identified as potentially clean fill is to be transported to stockpile location 2
- 2) Material is to be stockpiled on site and spread out and inspected/sampled in accordance with the requirements specified within the Site Auditor and ACT EPA approved RAP
- 3) Where **no visual or olfactory indications of contamination are noted** the material is to be re-used as clean fill within the Stage 2 excavation area
- 4) Where ACM is identified, the material is to be transported to the fill placement location
- 5) Where contamination is identified requiring the material to be disposed off site is noted, the material is to be transported to a licensed land fill facility in accordance with the requirements specified within the Site Auditor and ACT approved RAP.

Stockpile Area 3

- 1) Material identified as potentially containing asbestos is to be transported to stockpile location 3
- 2) Material is to be stockpiled on site and spread and inspected in accordance with the requirements specified within the Site Auditor and ACT EPA approved RAP
- 3) Where no ACM is identified the material is to be re-used as clean fill within the Stage 2 excavation area
- 4) Where ACM is identified, the material is to be transported to the fill placement location

Figure 33 Development Stage 2



6.5 Remediation Option 4 - Development Stage 3

The process for Development Stage 3 is detailed below and illustrated on Figure 34

Causeway Residential Site

- 1) Development Complete

Clean Fill Excavation Location

- 1) Clearance of surface vegetation within required excavation area only;
- 2) Continuation of 'clean fill' excavation works within the south eastern portion of the Site.
 - a. Excavation works are to be undertaken to maximise the vertical extent and minimise the lateral extent of excavation as far as practicable
 - b. Excavation works are to be staged to ensure adequate space is created for the placement of impacted fill material, while not creating a surplus of clean fill material.

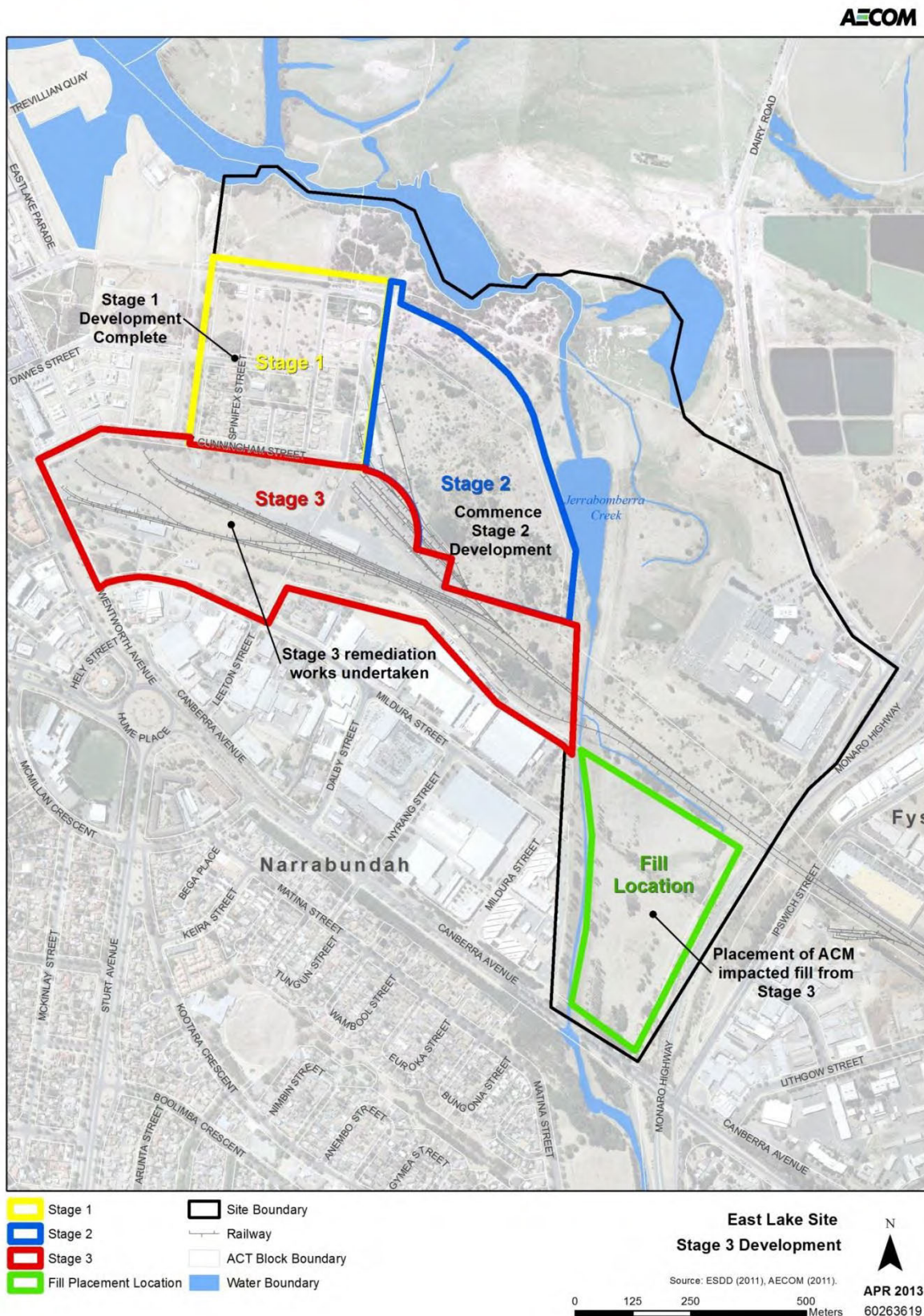
Stage 2 Area Development Area

- 1) Construction of roads and upgrades of required services/utilities;
- 2) Sale of blocks to private developers; and
- 3) Commencement of development works in accordance with required environmental management plans

Stage 3 Area Development Area

- 1) Clearance of surface vegetation;
- 2) Installation of sediment and erosion control measures;
- 3) Installation of Site dewatering measures;
- 4) Remediation of identified TPH impact hotspots in accordance with the Site auditor and ACT EPA approved Remediation Action Plan/Strategy;
- 5) Excavation and onsite screening/inspection of fill material in accordance with the Site auditor and ACT EPA approved Remediation Action Plan/Strategy. AECOM expects that due to the limited fill volumes identified within Stage 3, all stockpile management can be undertaken within the Stage 3 boundary;
 - a. Material identified to be ACM impacted to be transported directly to fill placement location
 - b. Material identified as potentially requiring offsite disposal transported to stockpile area 1
 - c. Material identified as potentially clean material transported to stockpile location 2
 - d. Material identified as potentially containing ACM material transported to stockpile location 3
- 6) Upon completion of excavation works (complete or staged approach) backfilling and compaction of excavation area with clean fill;
 - a. Clean fill material to be sourced from stage 3 excavation area and clean fill excavation location only.

Figure 34 Development Stage 3



6.6 Development Stage 4

The process for Development Stage 4 is detailed below and illustrated on Figure 35

Causeway Residential Site

- 1) Development Complete

Stage 2 Area Development Area

- 1) Development Complete

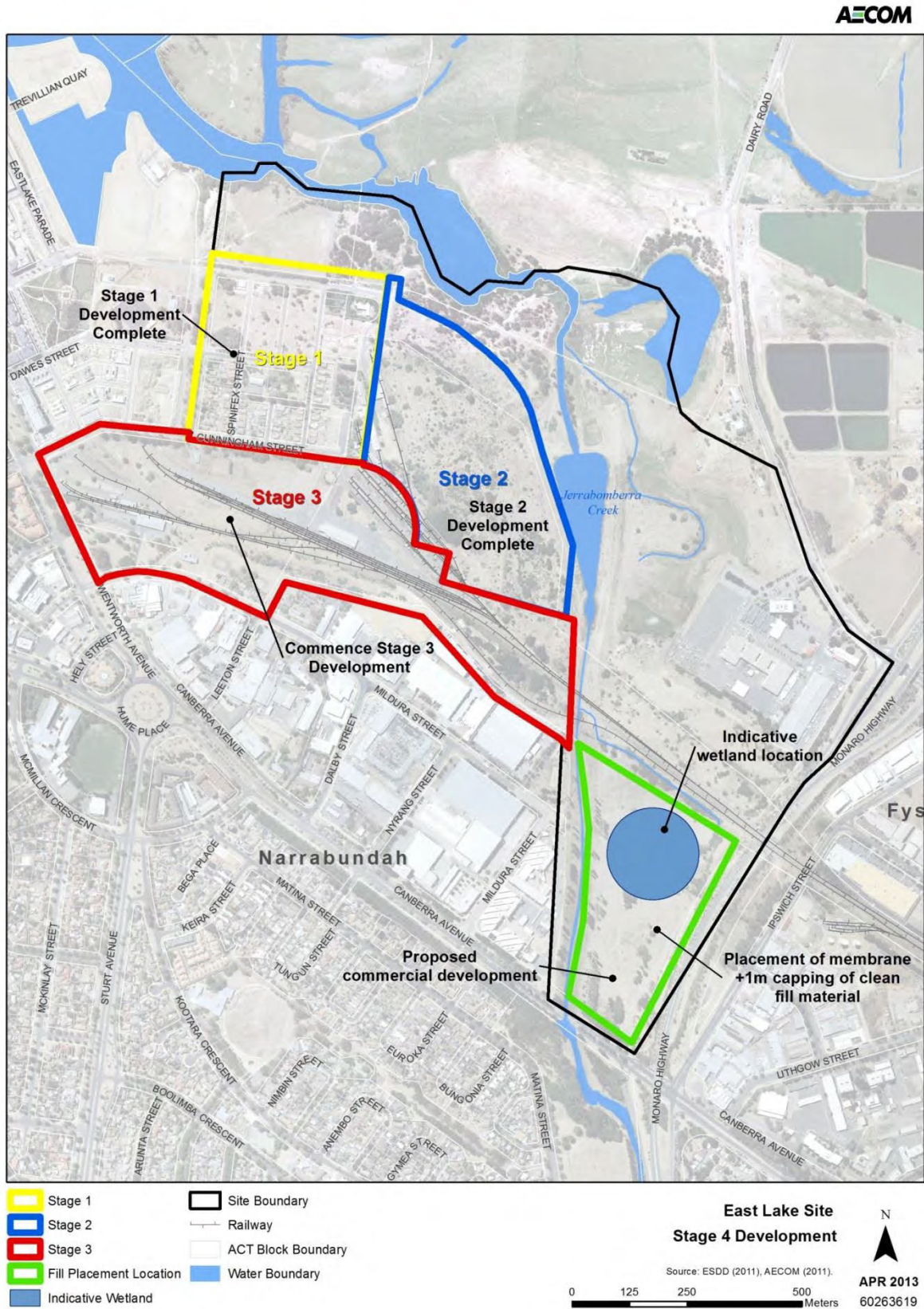
Stage 3 Area Development Area

- 1) Construction of roads and upgrades of required services/utilities;
- 2) Sale of blocks to private developers; and
- 3) Commencement of development works in accordance with required Environmental Management Plans.

Clean Fill Excavation Location

- 1) Completion of excavation works;
- 2) Installation of geofabric marker layer;
- 3) Development and approval of ongoing Environmental Management Plan for capped ACM waste materials;
- 4) 1 m of clean fill to be imported for clean capping layer;
- 5) Capping layer to be compacted to required condition;
 - a. It should be noted that additional geotechnical improvements (geo-grids etc) may be installed within the Site to enable commercial 'slab on ground' development
- 6) Construction of stormwater treatment wetland (configuration and size to be determined at a later stage).

Figure 35 Development Stage 4



6.6.1 Post-Remediation Asbestos Management Plan

Following completion of Site remediation works, the potential exists for residual asbestos fragments to be located within the Site in discrete locations. It is the opinion of AECOM that an Asbestos Management Plan should be developed for the Site that specifies the processes and procedures to be undertaken where unexpected finds of asbestos fragments are noted/observed within the Site during post-remediation development works, such as services installation or basement construction.

Asbestos contamination to sites usually occurs discretely in certain impacted areas where waste may have been buried and it does not tend to degrade or spread over time. The risk to human health from asbestos is related to the inhalation of asbestos fibre. Therefore asbestos cement fragments present a negligible risk if undisturbed or correctly managed. Non-friable asbestos cement fragments may also generate elevated fibre levels if they are broken up and pulverised, such as may occur during excavation activities.

The aim of the Asbestos Management Plan will be to ensure that all works taking place at the Site after remediation do not result in workers at the Site or persons on adjacent properties being exposed to elevated fibre levels during construction work or subsequent Site use.

Additionally, the plan will identify the procedures to be adopted for management and disposal of any identified asbestos and associated impacted soil material.

While the specifics of the Asbestos Management Plan would require consideration of site specific details following remediation works, the Plan should include as a minimum (but not limited to) the following considerations:

Unexpected Finds

Given the history of the Site, there is the possibility of encountering unexpected in-ground finds including:

- Ash/slag and/or building rubble;
- Unusual soil staining or discoloration;
- Odour/s emanating from the ground during earthworks; and
- Fragments of potentially asbestos-containing products on the surface or unearthed during excavation.

Management of Unexpected Finds

During development works if an unexpected find is uncovered:

- Works are to immediately cease in the vicinity of the discovery;
- The Site foreman is to be immediately informed;
- The area immediately surrounding the unexpected find material is to be barricaded off to ensure Site works do not disturb the area until assessment is undertaken;
- A suitably qualified environmental scientist/Class A licensed asbestos assessor is to visit the Site and assess the discovery; and
- The relevant managing ACT agency is to be informed of the type, location and extent of any unexpected find. They will then notify the ACT EPA, Worksafe and the Site auditor as necessary.

Assessment of Unexpected Finds

The environmental scientist is to advise the required course of action for the find. This may include:

- Sample collection and laboratory analysis;
- A detailed assessment; and
- Preparation of an assessment report and Remediation Action Plan (if required).

For any significant amount of asbestos material identified that is likely to be in excess of the WA Guidelines, WorkSafe will normally require that this RAP be followed and the material removed from Site as Special – Asbestos Waste.

All reports are to be reviewed by the Site Auditor (if appointed) prior to works recommencing within the vicinity of the find.

7

EAST LAKE URBAN RENEWAL ECONOMIC ANALYSIS

EAST LAKE SITE PREPARATION FEASIBILITY STUDY

7.0 East Lake Urban Renewal Economic Analysis

7.1 Context

This cost-benefit analysis (CBA) provides an economic assessment of each remediation option. Its objective is to provide economic analysis that can assist Government in its overall decision about the preferred remediation option. As such, the CBA's results should be viewed as complementary analysis to the other engineering and environmental work undertaken for this project.

From an economic appraisal perspective, remediation of East Lake represents an effective investment decision for the ACT Government, due to the Site's anticipated high value relative to the cost of the remediation.

7.1.1 Contamination and remediation of land

Contamination is generally not a major issue in the south of Canberra due to a lack of heavy industry that has historically been undertaken in the area (Office of the Commissioner for Sustainability and the Environment, 2003). This makes the current state of East Lake, as a contaminated site, relatively unique in the ACT context. It also means that the ACT has few examples of contamination that are of an equivalent size and scale to East Lake. Table 26 provides a description of two other recent examples of remediation.

Despite the extent of contamination or the size of a contaminated site, contamination can negatively affect the value of properties as markets become more aware of the potentially lasting detrimental effects that contaminants can have on land. In certain instances, especially when information about contamination is incomplete, property markets may overreact. Prices may be more depressed than is seemingly rational, and the future commercial value of land understated.

In other instances, knowledge about a contaminant is so new or limited that there is a virtual absence of market data, and values have been overstated or inflated. In these instances, any desire to deliver lower assessments of contamination and remediation to the market may harm the longer term commercial value of re-developed sites (International Association of Assessing Officer, 2001).

Experience from other significant remediated sites provides important lessons about the relationship between contamination and the long term property values of core area real estate (such as those learned through the remediation of waterfront precincts that have delivered urban, commercial and community benefits) (Table 26). East Lake stands as one example, among many, of the potential to transform 'brown field' land into a viable commercial opportunity.

Table 26 Relevant Australian land remediation projects

SITE	DESCRIPTION	LESSONS
Kingston Foreshore Development Project, ACT	<p>This project involved the transformation of 37Ha of underutilised industrial land on the southern shore of Lake Burley Griffith in the ACT into a new residential and commercial precinct through the demolition of buildings, remediation of contaminated land and environmental validation of the land. The site had been occupied by various derelict buildings and contaminated with a range of materials reflecting previous uses including government printing presses and vehicle fleets, a power station and rail yards. For the remediation of the site a staged and multi-tiered approach was used with a Site Audit Scheme. Still on-going, on completion the Project is expected to have 1700--1800 dwellings and serviced apartments as well as speciality retail and commercial space.</p>	<ul style="list-style-type: none"> - Remediation for property development has been undertaken in the ACT.
Little Bay Cove, NSW	<p>This project has involved the development of the University of NSW Little Bay Campus (previously sports facilities and solar research building) into a residential subdivision development at 1408 Anzac Parade, Little Bay. Undertaken by CHOF5 Little Bay Pty Ltd (Charter Hall) this \$600 million project involves site remediation, bulk earthworks, infrastructure and services works, demolition of all structures on site, associated landscaping and subdivision of the site into 28 residential lots and 10 super lots comprising approximately 450 dwellings.</p> <p>At the Little Bay site, a number of remediation options were considered for the site in order to determine the most appropriate according to commercial, environmental and social and health parameters (EIS, 2007). The final remediation works program involved the excavation and offsite disposal of waste materials particularly from the eastern (former landfill) portion of the site and the excavation, remediation and validation of material determined suitable for re-use. While the first development on the site will not be complete for another two years, it is expected that apartment prices will attract above market values for the area (Lawes, 2011).</p>	<ul style="list-style-type: none"> - Higher value properties with higher amenity appear to be less affected by stigma issues assuming an appropriate remediation process is implemented.

Source AECOM

Redevelopment and the creation of urban infill from former 'brown field' sites such as service stations and uncontrolled fill sites, has created new challenges for the ACT Government and developers with respect to management, re-use and disposal of hydrocarbon and asbestos-contaminated soils (Office of the Commissioner for Sustainability and the Environment, 2011). The Kingston Foreshore Development Program is a relevant example of how the challenges of remediation were overcome to optimise their commercial opportunity through development. The current sales of the dwellings in the new Kingston precinct are recognition of the benefit that can be accrued by government and developers, as well as the community, from undertaking remediation.

7.2 Approach

7.2.1 Scope

The objective of the CBA is to provide an analysis of each remediation option considered in this report. In order to meet this objective, the following scope of work was undertaken by AECOM:

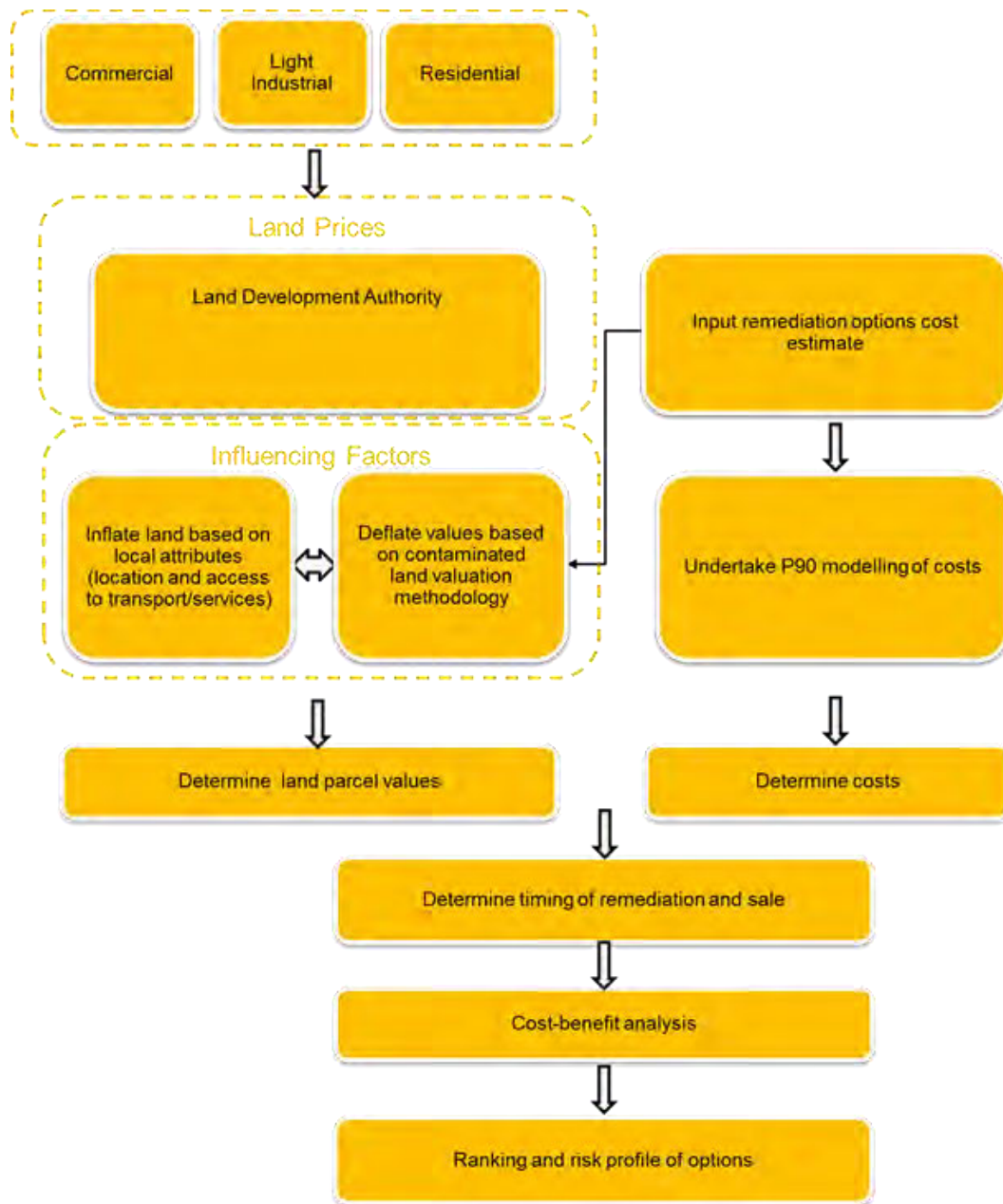
- Identify and quantify costs for each of the remediation options and formulate risk-adjusted P50 and P90 confidence intervals by taking into account the uncertainty of the remediation costs;
- Identify and quantify benefits associated with each of the remediation options;
- Undertake detailed CBA assessing the timing and magnitude of quantifiable costs and benefits and discounting these to the present as Net Present Values (NPVs)
- Conduct sensitivity analysis to test assumptions used in the modelling; and
- Consider other costs and benefits (such as environmental and social) where they will have a material impact on the outcomes of this analysis.¹
- Assess sensitivities and risks.

7.2.2 Analytical framework

The CBA has been undertaken using the analytical framework shown in Figure 36. The framework was developed specifically for the purposes of this project, using standard economic appraisal methodologies and by drawing on the Australia and New Zealand Property Council Guidelines for valuing contaminated land (2012), as well as US standards issued by the International Association of Assessing Officers (2001).

¹ A Triple Bottom Line Analysis was initially requested by ESDD. However, following discussion about project scope and timeframes it was agreed that a broad interpretation of the costs and benefits for inclusion in the CBA was sufficient to meet this aspect of the work.

Figure 36 Analytical framework



Source Developed using various sources

Additional information about how the CBA was undertaken against this framework is provided in the supporting technical note to this section at Appendix C.

7.2.3 Assumptions

The CBA's key underpinning assumptions are shown in Table 27.

Table 27 Key assumptions

ASSUMPTION	VALUE
Appraisal start year	2012
Price year	2012
Appraisal duration	30 years
Real discount rate after tax	7%
Remediation start year	2013

Source AECOM

The other key assumption is that the 'do nothing' scenario has no material costs. That is, leaving the East Lake site as it currently is does not impose material costs on the government and broader community. Therefore, the remediation options are the 'with project options'.

Under the 'do nothing' scenario, it is assumed that the East Lake precinct will continue to be sealed-off from the public, and any potential to use the land for other purposes would not materialise.

7.2.4 Exclusions

In undertaking the CBA of the remediation options, it is recognised that the preliminary nature of the options precludes a detailed analysis that includes all potential factors. The analysis focuses on determining critical impacts on the costs and benefits of the options for the purpose of comparison. Therefore, several elements have been excluded on the basis of insufficient data or immaterial for the comparison. The excluded elements include:

- The quantification of the impact of Option 1 on the ability of the developers to efficiently and effectively develop the sites. There is insufficient information on the magnitude of costs that may be faced by the developers due to potential contamination and it is only qualitatively described in the CBA.
- The impacts of staging are not incorporated into the CBA as a detailed staging programme for the remediation is anticipated to be developed in subsequent studies. Sensitivity analysis is conducted on the impact of an extended remediation duration.
- The costs to government of managing the remediation including the costs of establishing any entities charged with managing or overseeing the chosen remediation option as well as future regulatory and project development costs such as the development of an Environmental Impact Statement.

7.2.5 Data and information sources

The main data used for the CBA were derived from:

- Original and revised draft Planning Design Frameworks (PDF);
- Housing prices from real estate data bases. Housing prices were also determined through triangulation with other sources, such as the LDA's Quarterly Reports on Land Prices; and
- Capital Expenditure (Capex) and Operational Expenditure (Opex) from technical teams within AECOM. For example, senior leaders from AECOM's Program, Cost Consulting (PCC) team provided the verified costing data used for this project.

The analysis underpinning the CBA was also informed through a review of national and international guidelines for valuing contaminated land. The most significant of these guidelines included:

- The Australian Property Institute's 2012, *Australia and New Zealand Valuation and Property Standards*, namely sections relating to Land Contamination Issues (see section 12.1.1) and Valuation of Contaminated Land (see section 13.1.1); and
- The International Association of Assessing Officers' 2001, *Standard on the Valuation of Properties Affected by Environmental Contamination*, Chicago, USA.

7.3 Analysis of costs and benefits

This section provides a detailed description of the how the costs and benefits of each option were determined for each option.

7.3.1 Land areas

Analysis of costs and benefits is based on the total area of the Site. Land areas are an important determinant in understanding the land values and ultimately the financial benefits associated with each option.

Land areas for each type of land use (e.g. residential and commercial) have been used in lieu of other measures (e.g. dwelling numbers and other specific attributes). This is because the ACT Government will be responsible for the sale of land, as opposed to dwellings, buildings and other physical structures located on the site.

The land areas that have been identified for Options 1 to 3 are provided in Table 28. The table clearly shows that a significant proportion of the land area (approximately 93 per cent) has been earmarked for high value residential development.

Table 28 Option 1 to 3 - land take details (m²)

TYPE	CLASSIFICATION	AREA (m ²)
Residential	Total apartment lots	
	Mews	
	Terrace	
	Compact	
Commercial	Commercial	
Total development land take		

Source Simpson and Wilson Architecture and Design 2012

The land areas that have been identified for Option 4 are provided in Table 29.

Table 29 Option 4 residential and commercial areas

TYPE	CLASSIFICATION	AREA (m ²)
Residential	Multi-unit 6 Storeys (footprint only)	
	Multi-unit 3 Storeys	
	Mews	
	Terrace	
	Compact	
Mixed Use/Commercial	Commercial in Mixed Use	
	Pure Commercial	
Total		

Source Simpson and Wilson Architecture and Design 2012

The key difference between the land take for Options 1 to 3 and Option 4 is that Option 4 has a lower land take due to the reduced land available following the remediation. The other difference is that Option 4 has a higher proportion of commercial/mixed use land compared to Options 1 to 3.

7.3.2 Estimated costs of remediation

The remediation costs were determined by estimating the physical costs of clean up as well as the other ongoing expenses related to each option. The International Association of Assessing Officers’ 2001 Standard identifies the following costs that will impact on the value of contaminated land:

- physical clean-up costs; and
- other costs, including ongoing monitoring costs, legal costs, and indirect costs such as restrictions on future land use.

Physical clean-up costs

Three levels of ACM have been impacted by the need for physical remediation; the costs have been estimated by AECOM’s PCC team (Quantity Surveyors) to be:

- 100% fill volume (high);
- 60% fill volume (likely); and
- 10% volume (low).

The middle level value of 60 per cent was used as the baseline for estimating the clean-up costs of each option. This value was chosen to ensure that the costs used in the CBA represent the most realistic scenario for the East Lake site.

The estimated values of these costs for the 60% fill volume, by major cost category, are provided in Table 30. The table shows that offsite disposal of asbestos will be the most significant cost associated with Options 1– 3. It also shows that these costs are proportionately considerably lower for Option 4.

Table 30 Estimated values for physical clean-up costs (000’s) – baseline costs estimated at a 60% fill volume

COST ITEM	OPTION 1	OPTION 2	OPTION 3	OPTION 4
Preliminaries				
Site Set Up				
Onsite Works				
Site Supervision				
Total				

Source Based on estimates by AECOM’s Program, Cost, Consultancy team, 2012

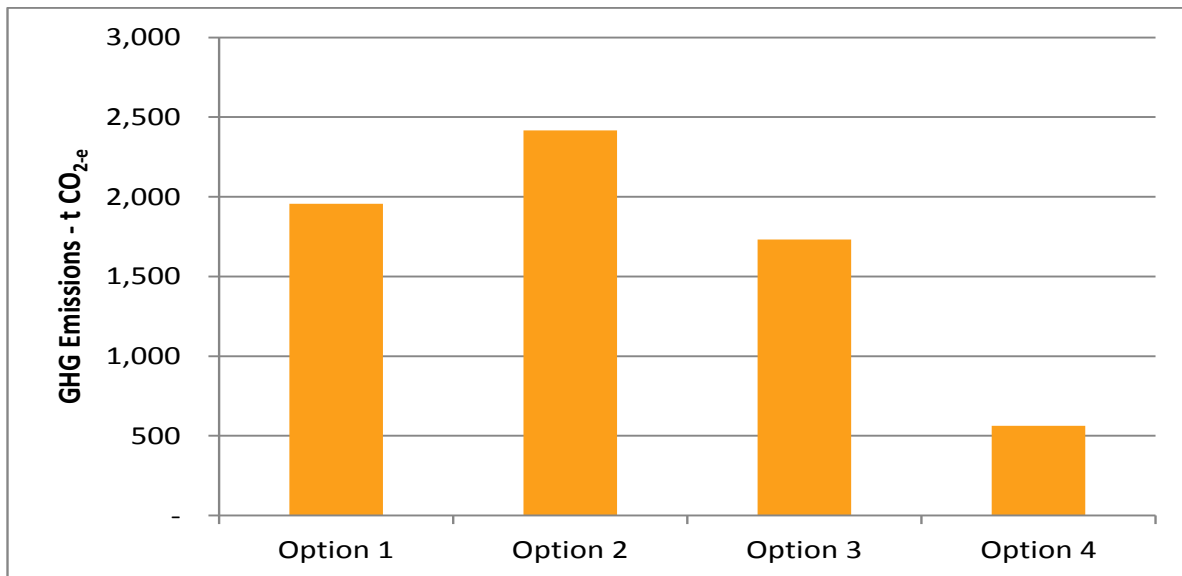
The estimated values for upper, middle level (baseline) and lower value costs, rounded to the closest [redacted] dollars are summarised in Table 31. Once again, the table shows that the physical clean-up costs of Options 1--3, are considerably higher at each value level than Option 4.

Table 31 Estimated values for physical clean-up costs (rounded to closes [redacted]) – upper, middle level, and lower values

	OPTION 1	OPTION 2	OPTION 3	OPTION 4
High				
Likely				
Low				

Source Based on estimates by AECOM’s Program, Cost, Consultancy team, 2012

The greenhouse gas (GHG) emissions associated with the transport of fill to landfill under each option is shown in Figure 37. The transport of fill assessment is based on the high cost option.

Figure 37 GHG emissions associated with fill transport

Source AECOM

Option 4 has lower GHG emissions due to the significantly less amount of fill transported to and from the East Lake site.

Other costs

Ongoing monitoring costs were identified, but deemed to be immaterial relative the physical costs of clean-up. For this reason, ongoing monitoring costs have not been quantified for each option.

Legal costs have been identified as a significant potential risk to the future development of East Lake. High profile and landmark cases concerning asbestos indicate that the future legal costs for East Lake could be significant. However, at this stage of the analysis it is impossible to determine what level these costs could comprise for each option.

Other indirect costs (such as those relating to noise pollution and increased congestion caused by offsite disposal) were considered, but not valued in this stage of the analysis. Further consideration of these factors will be necessary when the preferred option is determined and a detailed Remediation Action Plan is developed for the Site.

Indicative P50 / P90 modelling of costs

A high-level P50 / P90 modelling was undertaken on the costs identified for each option. P50 / P90 modelling is a statistical technique used to make risk-adjusted estimations by taking into consideration the uncertainty of events in the future, in this case, in relation to remediation works undertaken at East Lake.

Risk-adjusted modelling is undertaken by assessing the impact of potential 'high' and 'low' project cost overruns using Monte Carlo simulations – a technique used to generates the probability distribution of projected costs.

The results of the modelling of Options 1–4 is shown in Figure 38.

Figure 38 Probability modelling of Option 1–4

Note The results of this modelling have been based on rounded estimates of physical costs. As such these results should be viewed as indicative only. Further detailed and more accurate costing would provide greater certainty in the results of the modelling.

Source Based on AECOM's analysis

The results in Figure 38 shows that the distribution of likely costs of Options 1 to 3 converge, meaning that there is a strong chance the costs under the three options will be similar. Option 4 has a tighter distribution of total costs suggesting that remediation costs under Option 4 are less susceptible to volatility. This reduction in volatility is a result of a lower requirement for transporting fill under Option 4 in comparison with Options 1–3

The distribution of Options 1–3 are broader and represent the higher risk posed by the potential variability of cost associated with treating and transporting the fill. The higher fill treatment increases the costs.

7.3.3 Estimated benefits of remediation

Remediation benefits were determined by identifying the potential post-remediation land value under each of the options, before adjusting them by factors that can have both positive and negative impacts on these values. The results of this analysis are provided below.

Land values analysis

Land value has been identified as the single largest source of benefit arising from remediation. This is because the Site is currently unused and post-remediated land can be sold to private investors by the ACT Government.

The potential value of post-remediated land was calculated by multiplying the total area of various residential, commercial and light industrial mixes (as discussed in Section 7.3.1) by corresponding per square metre values of land. However, it is important to note that these values do not represent a formal commercial property valuation of the site.

The benefit of this approach (in conjunction with the application of land value adjustment factors) is that it allows for a broad estimation of aggregate land values in the context of significant uncertainties around the details of design and commercial value of the planned development of East Lake. General assumptions pertaining to the value of land at the East Lake precinct can be checked through the process of sensitivity analyses.

Value of land per square metre for various housing and commercial mixes was extrapolated from land sales data that is publically available on the LDA website. The land values from the LDA are shown in Table 32 and recreated in the Appendix B to the CBA.

Table 32 LDA average values for raw land by land use category

LAND USE TYPE	VALUE PER SQUARE METRE (\$/m ²)
Commercial	
Community	
Englobo	
Industrial	
Mixed-Use	
Multi-Unit Residential	
Residential	
Terrace	
Mixed-Use/Childcare	

Source LDA land sales data, June 2010 - October 2012

Using the per square metre value of land outlined above and the draft PDF options considered for this project, the total unadjusted value of land is calculated in Table 33. Differences in the unadjusted land values are due to the availability of land (timing of release under options), as well as the mix of land types under each option.

Table 33 Total value of land under each PDF - unadjusted

PDF APPLIED	TOTAL UNADJUSTED LAND VALUE (\$million)
PDF applied to Options 1– 3 (see Error! Reference source not found.)	
PDF applied to Option 4 (see 0)	

Source AECOM based on LDA 2012

7.4 Adjustment Factors

The land value data released by the LDA is generally for outer suburbs (Gungahlin, Harrison etc.). It is recognised that the land values used for the benefits of the East Lake remediation options should recognise the proximity of the East Lake to key services and landmarks. Therefore, the land values should be adjusted based on a 'proximity' factor. Other adjustment factors that were considered by AECOM, but were unable to be quantified are summarised in the Appendix to the CBA.

Proximity to transport services, facilities and key landmarks

Core area property with close proximity to transport services, community facilities, and key national landmarks has historically retained a high value within Canberra. Table 34 provides a high-level assessment of comparable real estate values between the suburbs of Kingston (used as a proxy for East Lake since it is located adjacent to the precinct) and suburbs further away from Parliament House.² Belconnen, Gungahlin and Harrison were chosen as the comparative suburbs since a large proportion of Land Sale prices sourced from LDA were for sales made in these locations. The figures clearly demonstrate that housing sold in Kingston is considerably more expensive than the compared suburbs.

Additional comparative Land Sales prices data are provided in the Appendix to the CBA.

² Parliament House was used as a proxy for the Canberra's 'hub' since major government offices such as Department of Foreign Affairs and Trade, Australian Treasury and other major public facilities such as the National Library and the National Art Gallery are located within a radius of 500 metres from this location. Furthermore, the Canberra Civic area where many of the city's retailers concentrate, is also within one kilometre of Parliament house.

Table 34 Average house values – Kingston and selected ACT suburbs

SUBURB	1 BEDROOM	2 BEDROOM	3 BEDROOM	4 BEDROOM	AVERAGE
House					
Belconnen					
Gungahlin					
Harrison					
Kingston					
Unit					
Belconnen					
Gungahlin					
Kingston					

Adjusted values

The price differential observed between Kingston’s property values and that of the comparison suburbs were applied to the unadjusted total value of land in Table 33, to obtain the *adjusted value of land* at the post-remediated East Lake precinct. These have been summarised in Table 35.

Table 35 Adjusted values for raw land by land use category – East Lake

LAND USE TYPE	VALUE PER SQUARE METRE (\$/m ²)
Commercial	
Community	
Englobo	
Industrial	
Mixed-Use	
Multi-Unit Residential	
Residential	
Terrace	
Mixed-Use/Childcare	

Source Adjusted from LDA land sales data, June 2010 – October 2012

AECOM has explored a range of economic, financial, social, environmental and legal factors that are likely to impact on the value of land sold under each option. The potential factors have been identified in the Appendix to the CBA.

Using the per square metre value of land outlined above and the draft PDF options considered for this project, the total unadjusted value of land is calculated in Table 36. Differences in the unadjusted land values are due to the availability of land (timing of release under options), as well as the mix of land types under each option.

Table 36 Total value of land under each PDF - unadjusted

PDF APPLIED	TOTAL UNADJUSTED LAND VALUE (\$million)
PDF applied to Options 1 to 3 (see 2.13)	
PDF applied to Option 4 (see 0)	

Source AECOM based on LDA 2012

7.4.1 Timing of land release

The assumed timeframes relating to each of option is shown in Table 37. The timeframes for which land becomes available for sale will be an important determinant in how land values for each option are realised by the ACT Government.

The timing of land release following remediation has been derived from discussions between the design team and ESDD. AECOM acknowledges that the ACT land release plans stipulate that parts of the East Lake precinct to be released to property developers as early as 2014. The assumed land sale date shown in the table is for the entire precinct although in reality, it is anticipated that sections of the precinct will be released over a staggered period. Therefore, at this stage, it is important to note the highly indicative nature of these timeframes. The duration of remediation was provided for the economic appraisal by the AECOM PCC team.

As shown, for the CBA, it was assumed that the East Lake precinct will sell immediately after the site goes on sale to property developers 18 months after the completion of remediation under each Option.

Table 37 Assumed timing of land release and sale

OPTION	REMEDATION DURING (from 1 st July 2013)	LAND HOLDING PERIOD (from end of remediation)	ASSUMED LAND SALE DATE
Option 1	22 months	18 months	31 st October 2016
Option 2	28 months	18 months	30 th April 2017
Option 3	20 months	18 months	31 st August 2016
Option 4	10 months	18 months	31 st October 2015

Source AECOM

7.4.2 Stigma associated with contamination – impact on potential buyers

Stigma is an intangible factor that may be difficult to measure but may have real impact on the market value of contaminated land. Stigma arises when present or past contamination affects a buyer's perception of the property value, and represents a discount required to compensate for the risks associated with purchasing a presently or previously contaminated property. Importantly, the amount of compensation required to address stigma typically exceeds the direct and indirect costs likely to be incurred by the investor, as it often internalises the risk of bearing the burden of having to remediate residual contamination that may or may not arise in the future.

Stigma makes property less desirable, even when a complete remediation or clean-up has been carried out. That is, where there is a market perception that a property is or has been contaminated, despite the availability of information that clean-up has taken place, the market will often pay less than normal unaffected values. This situation is similar to obsolescence and represents a lingering detriment to a property. In some cases the stigma effect is variable with time or is transitory.

On the other hand, there is also evidence suggesting the stigma declines with the passing of time. However the timing and scale of this decline is site specific and may require consultation to accurately understand and incorporate into decision-making.

7.5 Results of the CBA

This section provides the results of the CBA for each option. The valuation of the costs and benefits has been undertaken based on the methodologies shown in the Appendix to the CBA.

7.5.1 CBA modelling

CBA models approximate the complex real world and consequently have limitations that affect the interpretation of results. Despite this, models examine complex issues logically and consistently across long timeframes. As with all modelling assessments, the modelling results require careful explanation. It is also sensible to undertake sensitivity analysis to evaluate the robustness of the key messages obtained from the modelling analysis.

Assumptions used in the CBA modelling are aimed at only providing an indicative ‘what is likely to happen’ situation under each remediation option, and should therefore not be confused as robust forecasts of land sale prices of East Lake. In accordance with conventional CBA practice, sensitivity analyses was undertaken to ‘sanity-check’ the uncertainty associated with each of the key assumption parameters. The results of the sensitivity analyses have been provided in Section 7.5.3.

7.5.2 Net present values

Net Present Values (NPV) are used to compare the benefits and costs that may be actualised at different timings over the course of a project lifecycle by converting all the monetary values identified under the CBA into present-day values. By doing so, the overall net benefit of a project can be determined, accounting for inflation and discount rates.

NPV is an indicator of how much value an investment or project adds. This does not necessarily mean that the positive NPV project should be undertaken since NPV at the cost of capital may not account for opportunity cost, i.e., comparison with other available investments. In theory, if there is a choice between two mutually exclusive alternatives, the one yielding the higher NPV should be selected.

As endorsed by the Commonwealth Department of Finance and Deregulation (2009), from a regulatory perspective, NPVs are preferable as the criterion of decision for project proposals over benefit-cost-ratios (BCRs) since they provide the absolute size of the net social benefit of a proposal, as opposed to the relative size of costs and benefits.

Table 38 shows that Option 3 has the highest NPV of all options, before the sensitivity analysis, including the potential impacts of stigma on land values, is applied to the analysis. In other words, the NPVs shown in this table represent the economic viability of the proposed PDFs assuming that there is no negative impact on property values as a result of stigma attached to a previously contaminated site.

Compared to Options 1 and 2, Option 3 yields the highest NPV since the remediation cost is relatively lower whilst the expected benefit from land sale is the same across the three remediation approaches (as a result of having the same PDF). Option 4 has a lower NPV since the expected benefit from land sale is lower than for Options 1 to 3, despite remediation costs being lower.

The NPVs taking into consideration the impact contamination has on property values (through stigma) have been provided in Section 7.5.2.

Table 38 NPV of Options (2012 \$m)

OPTION	NPV (2012 \$m)
Option 1	
Option 2	
Option 3	
Option 4	

Source Based on AECOM's analysis

The cumulative NPV graph is shown in Figure 39.

Figure 39 Cumulative NPV – unimpaired land values (NPV 2012 \$m)



Source Based on AECOM's analysis

The cumulative NPV graph shows that each option incurs costs to complete the remediation and then the net position of the project moves back to positive NPV due to the revenue from the sale of the remediated land. All of the options return to a positive NPV when the unimpaired values of the land are used in the analysis. Options 1 and 3 have the highest cumulative NPV due to the lower remediation costs.

7.5.3 Sensitivity analysis

Sensitivity on key inputs in the CBA is a critical element of determining the robustness of the analysis. The results of the sensitivity analysis are show below.

Stigma

The average stigma has been calculated based on the previous use for the East Lake site for use as sensitivity analysis. A detailed discussion of the Stigma Sensitivity Analysis is in the Appendix C to the CBA.

Table 39 Sensitivity analysis – stigma and remediation options

OPTION	REMEDICATION	STIGMA SCENARIO
Option 1	Clean environmental hotspots, cap uncompacted fill area as required. Management of general geotechnical and environmental issues would be managed by individual Site developers	Average
Option 2	Remediate the whole of the fill for geotechnical and environmental contamination by excavation, removal of unsuitable materials and replacement of the soil materials as controlled fill	Low
Option 3	Clean environmental hotspots and use partial excavation in conjunction with ground improvement such as impact rolling to improve the geotechnical properties of the Site followed by adequate controlled fill capping	Average
Option 4	Excavation of clean fill material from south eastern portion of the Site and excavation of contaminated and geotechnically unsuitable fill material from the central portion of the Site. Contaminated and geotechnically unsuitable fill material is transported and placed within the south eastern portion of the Site where upon completion of the excavation is capped with a 1 m thick layer of clean fill material.	High

Source Appendix C

The results of the sensitivity analysis on the impact of stigma are shown in Table 40.

Table 40 Stigma sensitivity analysis – NPV (2012 \$m)

OPTION	NPV (2012 \$m)
Option 1	
Option 2	
Option 3	
Option 4	

Source Based on AECOM's analysis

The cumulative NPV of each option under the stigma sensitivity analysis is shown in Figure 40.

Figure 40 Stigma sensitivity analysis – NPV (2012 \$m)



Source Based on AECOM's analysis

The Stigma Sensitivity Analysis reveals that stigma can materially affect the NPV of the options. Appendix C demonstrates that remediated commercial land attracts lower stigma than residential land.

The highest NPV is under Option 4 even though this option was allocated the highest relative stigma. The reason that the NPV for Option 4 is least affected by stigma is that the Option 4 has significantly more commercial land and lower residential land than the other options. This is in contrast with Options 1–3 which have a higher proportion of residential land and these land values are materially reduced by the Stigma Sensitivity Analysis.

Sensitivity analysis has been conducted on the unimpaired value of the land. The key variables that have been tested are:



The results of the sensitivity analysis are shown in Figure 41.

Figure 41 Sensitivity analysis – NPV (2012 \$m)



Source Based on AECOM's analysis

The sensitivity analysis conducted on other variables does not affect how the options are ranked, however the NPVs move significantly as a result of changes in key variables. The most significant impact is the change in fill that requires treatment under the remediation options. An optimistic scenario of treating █% of the fill significantly decreases the remediation costs and increases the NPV. A higher percentage (█%) of fill requiring treatment results in a significant decrease in the forecast NPV including a negative NPV for Option 2.

A second set of sensitivity analysis was undertaken on the potential impact of changes in the adjustment rate from the LDA land values, which are predominantly from property released in outer suburbs, to the potential land values of the East Lake site given its proximity to key services. The two scenarios are:

- Higher land values adjustment due to proximity of East Lake site – a higher (█%) increase in land values from the LDA values to East Lake specific values
- Higher land values adjustment due to proximity of East Lake site — a lower (█%) increase in land values from the LDA values to East Lake specific values.

The results of this sensitivity analysis are shown in Figure 42.

Figure 42 Remediation duration sensitivity analysis



Source AECOM

The sensitivity analysis on the impact of an increase in remediation duration suggests that there is minor impact from increasing the duration of the remediation based on the factors quantified in this CBA.

7.5.4 Rankings and risk profiles

The results of the CBA and sensitivity analysis suggest that Option 4 has the highest NPV with Option 3 having the second highest NPV. Option 2 has the highest remediation costs and these costs result in a lower NPV even accounting for the lower stigma relative to the other options tested in the sensitivity analysis.

The probabilistic modelling of the total remediation costs was applied to the CBA and the resulting NPV for each of the options are shown in Figure 43.

Figure 43 Distribution of NPV – unimpaired land values (2012 \$m)



Source Based on AECOM's analysis

The probabilistic modelling show that the range of potential NPV for Option 3 is higher than Option 4 and that Option 2 and 3 have a probability (5%) of a negative NPV. Option 4 has the least volatility in likely NPV with all the potential NPV being greater than zero.

7.6 Cost Benefit Analysis Key findings

The key findings to arise from the CBA are:

- All of the options appear to provide a positive NPV, with the probabilistic analysis suggesting that 95% of the NPVs will be positive. This is in part due to the high land values of the area containing East Lake;
- The potential for cost overruns in Options 1– 3 pose the largest risks to a positive NPV being generated from remediation;
- Stigma has the potential to materially impact land values. The analysis has shown that this impact will be greatest for residential properties, and lower for commercial properties. This means that Option 4, with a larger proportion of commercial property, may be less affected by stigma; Option 4 provides the highest positive NPVs (both before and after the sensitivity analysis), with Option 3 having the next highest NPV; and
- This analysis should not be read as a definitive assessment of each option's financial viability. Other issues that are currently unquantifiable, such as future legal liability, could have significant implications for the ranking of options.

8

CONCLUSIONS AND RECOMMENDATIONS

EAST LAKE SITE PREPARATION FEASIBILITY STUDY

8.0 Conclusions and Recommendations

AECOM Australia Pty Ltd (AECOM) was engaged by Environment and Sustainable Development Directorate (ESDD) to prepare a Site Preparation Feasibility Assessment for the site identified as the East Lake Urban Renewal Site (the Site).

The primary objective of this report is to assess the logistics and evaluate the feasibility of various site preparation options for contaminated and geotechnically unsuitable fill materials previously identified at the Site while considering remediation objectives, technical practicability, and logistical constraints.

Following assessment of existing site conditions AECOM developed the necessary steps/approach to be undertaken for three previously determined Site preparation options and one option developed by AECOM during this assessment;

- Option 1 – Clean environmental hotspots, cap uncompacted fill area as required. Management of general geotechnical and environmental issues would be managed by individual Site developers;
- Option 2 – Remediate the whole of the fill for geotechnical and environmental contamination by excavation, removal of unsuitable materials and replacement of the soil materials as controlled fill; and
- Option 3 – Clean environmental hotspots and use partial excavation in conjunction with ground improvement such as impact rolling to improve the geotechnical properties of the site followed by adequate controlled fill capping.
- Option 4 – Revision of the Planning and Design Framework, onsite containment of fill materials and re-use of excavated clean fill materials.

Analysis of the above site preparation options indicated that Option 4 was potentially the most suitable option based on the high re-use potential of materials within the site and the reduced requirement for offsite disposal.

In parallel to the site preparation options assessment AECOM undertook a cost-benefit analysis (CBA) to provide an economic assessment of each site preparation options.

The objective was to provide economic analysis that can assist ESDD in its overall decision about the preferred remediation option. As such, the CBA results should be viewed as complementary analysis to the other engineering and environmental work undertaken for this project.

The key findings of the CBA are:

- All of the options appear to provide a positive Net Present Value (NPV), with the probabilistic analysis suggesting that 95% of the NPVs will be positive. This is in part due to the high land values of the area containing East Lake.
- The potential for cost overruns in options 1 to 3 pose the largest risks to a positive NPV being generated from remediation.
- Stigma has the potential to materially impact land values. The analysis has shown that this impact will be greatest for residential properties, and lower for commercial properties. This means that Option 4, with a larger proportion of commercial property, may be less affected by stigma.
- Option 4 and Option 3 have essentially the same P50 NPV. However the range of NPVs for option 4 is narrower than for option 3, meaning that it is less risky.
- This analysis should not be read as a definitive assessment of each option's financial viability. Other issues that are currently unquantifiable, such as future legal liability, could have significant implications for the ranking of options.

Based on the information presented within previous environmental investigations, the information available relating to current site conditions and the calculated cost associated with site remediation (based on 2012/2013 cost estimates) , it is the opinion of AECOM that "Option 4" should be considered the most feasible methodology of remediating the site in preparation for subsequent Site sale and development due a combination of financial, social and environmental benefits.

9.0 References

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A

EXISTING ROAD ASSET CONDITION REPORT

EAST LAKE SITE PREPARATION FEASIBILITY STUDY



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Seven Hills (Sydney) 2147
NSW, Australia

Phone: +61 2 9674 9488
Fax: +61 2 9674 9345

28th May 2012

Dear Ramon,

During the survey, several parts of the roads could not be accessed by the crew due to closures:

Section Name	From	To	Length	Issue	Reason
Spinifex St	Sandalwood St	Newcastle St	52	Not surveyed	Road Closed
Spinifex St	Newcastle St	Sandalwood St	52	Not surveyed	Road Closed
Myrtle St	Sandalwood St	Newcastle St	170	Not surveyed	Road Closed
Myrtle St	Newcastle St	Sandalwood St	170	Not surveyed	Road Closed
Newcastle St	The Causeway	Blueberry St	50	Not surveyed	Blocked by gate
Newcastle St	Blueberry St	The Causeway	50	Not surveyed	Blocked by gate

Also the following sections have missing data due to equipment limitations:

Section Name	Direction	From Chain (km)	To Chain (km)	Length (meters)	Issue
Cunningham Street	Counter	0.630	0.650	20	No rutting data
The Causeway	Prescribed	0.320	0.350	30	No roughness data
Blueberry Street	Prescribed	0.310	0.350	40	No roughness data



All together, this represents about 12% of the survey as a whole.

Kind regards,

Anatoly Trapeznikov
Spatial Analyst

SURFACE DEFECT PLAN

HONEYSETT VIEW

-  - Intermediate fatigue cracking / heavy patching
-  - Widespread fatigue cracking / heavy patching



RUT DEPTH RESULTS

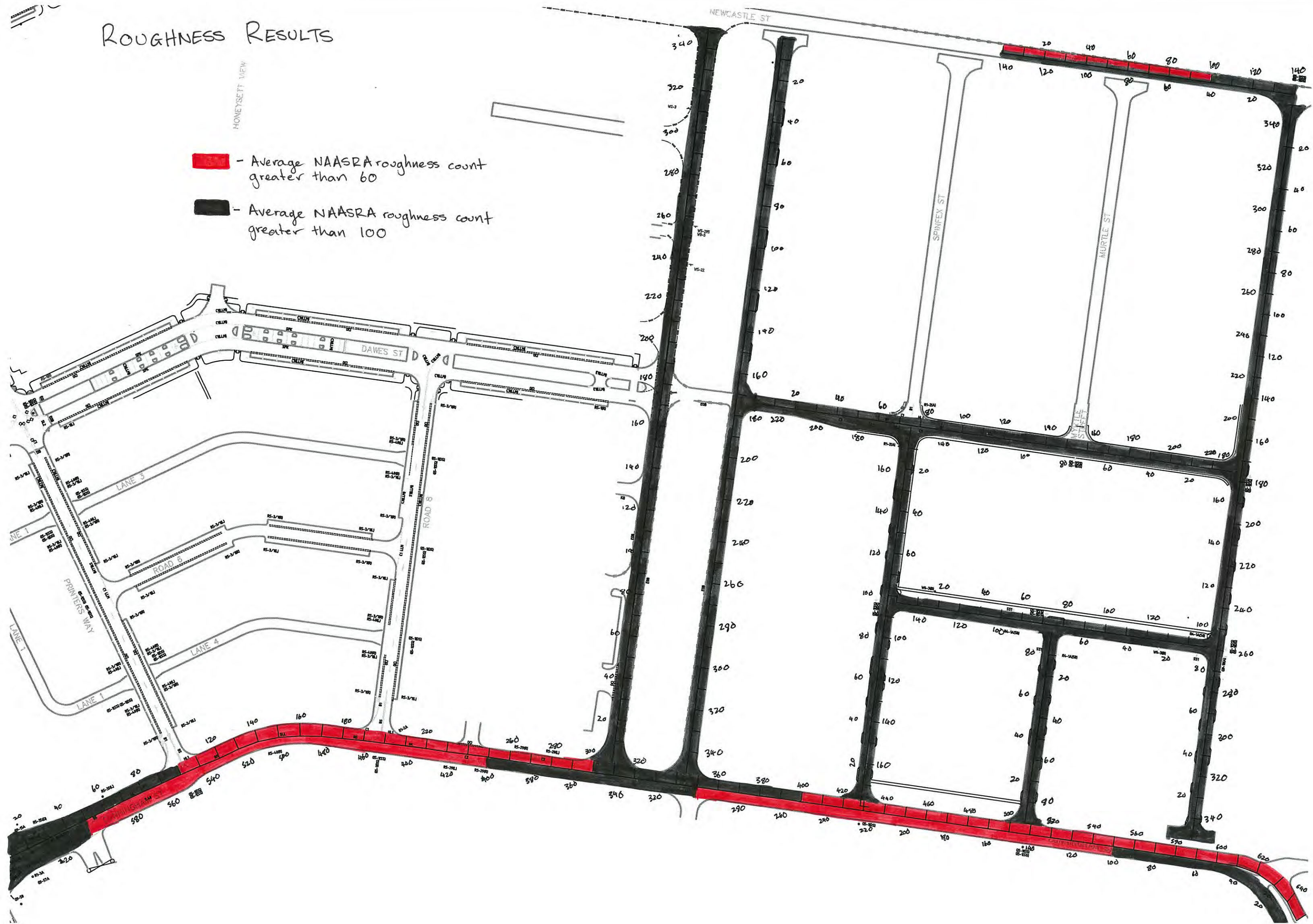
- More than 10% of length has a rut depth greater than 5 mm
- More than 10% of length has a rut depth greater than 10 mm



ROUGHNESS RESULTS

HONEYSETT VIEW

- Average NAASRA roughness count greater than 60
- Average NAASRA roughness count greater than 100





FUGRO PMS

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Visual Condition Test Report - Surface Defect Plot

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 1A1

Cunningham Street
from Wentworth Avenue to Geijera Place

Road Id: 1
Lane: 1
Block: A

Station Start	End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
		%Length	%Length	%Length	%Length	%Length	%Length
0.000	0.010		■	■			
0.010	0.020		■	■	■		
0.020	0.030		■	■			
0.030	0.040	■					
0.040	0.050	■	■				
0.050	0.060	■	■	■			
0.060	0.070						
0.070	0.080						
0.080	0.090						
0.090	0.100						
0.100	0.110						
0.110	0.120			■			
0.120	0.130						
0.130	0.140						
0.140	0.150						
0.150	0.160						
0.160	0.170						
0.170	0.180						
0.180	0.190						
0.190	0.200						
0.200	0.210						
0.210	0.220						
0.220	0.230						
0.230	0.240	■	■				
0.240	0.250	■	■				
0.250	0.260		■				
0.260	0.270		■				
0.270	0.280		■				
0.280	0.290		■				

Legend: No Occurance: Isolated: Intermediate: Widespread:

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Station		Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
Start	End						
km	km	%Length	%Length	%Length	%Length	%Length	%Length
0.290	0.300		Isolated				
0.300	0.310		Isolated				
0.310	0.320	Isolated	Intermediate				
0.320	0.330		Intermediate				
0.330	0.340		Intermediate				
0.340	0.350						
0.350	0.360						
0.360	0.370						
0.370	0.380						
0.380	0.390						
0.390	0.400						
0.400	0.410						
0.410	0.420						
0.420	0.430						
0.430	0.440	Isolated					
0.440	0.450						
0.450	0.460	Isolated					
0.460	0.470						
0.470	0.480	Isolated					
0.480	0.490		Intermediate				
0.490	0.500						
0.500	0.510						
0.510	0.520	Isolated					
0.520	0.530		Intermediate				
0.530	0.540						
0.540	0.550						
0.550	0.560						
0.560	0.570						
0.570	0.580						
0.580	0.590						
0.590	0.600						
0.600	0.610					Isolated	
0.610	0.620	Isolated					
0.620	0.630	Isolated					
0.630	0.640						
0.640	0.650						
Average		6.2%	11.1%	4.6%	1.5%	0.3%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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Visual Condition Test Report - Surface Defect Plot

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Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 1A2

Cunningham Street
from Geijera Place to Wentworth Avenue

Road Id: 1
Lane: 2
Block: A

Station Start	End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
		%Length	%Length	%Length	%Length	%Length	%Length
0.000	0.010						
0.010	0.020						
0.020	0.030						
0.030	0.040						
0.040	0.050						
0.050	0.060						
0.060	0.070						
0.070	0.080						
0.080	0.090						
0.090	0.100						
0.100	0.110						
0.110	0.120						
0.120	0.130						
0.130	0.140						
0.140	0.150						
0.150	0.160						
0.160	0.170						
0.170	0.180						
0.180	0.190						
0.190	0.200						
0.200	0.210						
0.210	0.220						
0.220	0.230						
0.230	0.240						
0.240	0.250						
0.250	0.260						
0.260	0.270						
0.270	0.280						
0.280	0.290						

Legend: No Occurance: Isolated: Intermediate: Widespread:

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Station		Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
Start	End	%Length	%Length	%Length	%Length	%Length	%Length
km	km						
0.290	0.300						
0.300	0.310						
0.310	0.320						
0.320	0.330						
0.330	0.340						
0.340	0.350						
0.350	0.360						
0.360	0.370						
0.370	0.380		Isolated				
0.380	0.390		Intermediate				
0.390	0.400		Intermediate				
0.400	0.410		Isolated				
0.410	0.420						
0.420	0.430						
0.430	0.440						
0.440	0.450						
0.450	0.460						
0.460	0.470		Isolated				
0.470	0.480						
0.480	0.490						
0.490	0.500						
0.500	0.510						
0.510	0.520						
0.520	0.530						
0.530	0.540		Isolated				
0.540	0.550		Isolated				
0.550	0.560		Isolated				
0.560	0.570						
0.570	0.580		Intermediate				
0.580	0.590						
0.590	0.600						
0.600	0.610						
0.610	0.620						
0.620	0.630		Isolated				
0.630	0.640	Intermediate	Isolated				
0.640	0.650						
Average		2.2%	9.2%	1.8%	0.3%	0.0%	0.3%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 2A1

The Causeway from Cunningham Street to Newcastle Street

Road Id: 2
Lane: 1
Block: A

Station Start	End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
		%Length	%Length	%Length	%Length	%Length	%Length
0.000	0.010						
0.010	0.020	■	■	■			
0.020	0.030	■					
0.030	0.040		■	■			
0.040	0.050		■				
0.050	0.060						
0.060	0.070		■				
0.070	0.080						
0.080	0.090		■				
0.090	0.100		■				
0.100	0.110		■	■			
0.110	0.120		■				
0.120	0.130		■				
0.130	0.140		■				
0.140	0.150		■				
0.150	0.160		■				
0.160	0.170		■				
0.170	0.180		■	■			
0.180	0.190			■			
0.190	0.200	■	■				
0.200	0.210		■				
0.210	0.220						
0.220	0.230		■				
0.230	0.240		■				
0.240	0.250		■				
0.250	0.260		■				
0.260	0.270	■	■				
0.270	0.280	■					
0.280	0.290	■					

Legend: No Occurance: Isolated: Intermediate: Widespread:

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Station		Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
Start	End						
km	km	%Length	%Length	%Length	%Length	%Length	%Length
0.290	0.300						
0.300	0.310						
0.310	0.320						
0.320	0.330						
0.330	0.340						
0.340	0.350						
Average		25.7%	26.3%	7.4%	0.0%	0.0%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 2A2

The Causeway from Newcastle Street to Cunningham Street

Road Id: 2
Lane: 2
Block: A

Station Start	Station End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
		%Length	%Length	%Length	%Length	%Length	%Length
0.000	0.010	Isolated	Intermediate				
0.010	0.020			Intermediate			
0.020	0.030			Widespread			
0.030	0.040			Widespread			
0.040	0.050		Intermediate	Isolated			
0.050	0.060		Intermediate	Intermediate			
0.060	0.070		Intermediate				
0.070	0.080		Intermediate				
0.080	0.090		Intermediate	Intermediate			
0.090	0.100		Widespread				
0.100	0.110		Intermediate	Isolated			
0.110	0.120		Widespread				
0.120	0.130		Intermediate	Intermediate			
0.130	0.140		Isolated	Widespread			
0.140	0.150		Widespread	Intermediate			
0.150	0.160		Widespread	Isolated			
0.160	0.170		Isolated				
0.170	0.180		Isolated				
0.180	0.190		Intermediate	Isolated			
0.190	0.200	Isolated	Widespread	Isolated			
0.200	0.210		Widespread	Intermediate			
0.210	0.220		Isolated	Widespread			
0.220	0.230	Isolated	Intermediate	Intermediate			
0.230	0.240		Intermediate	Widespread			
0.240	0.250			Widespread			
0.250	0.260		Isolated	Widespread			
0.260	0.270	Widespread		Isolated			
0.270	0.280	Widespread					
0.280	0.290	Widespread					

Legend: No Occurance: Isolated: Intermediate: Widespread:

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Station		Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
Start	End						
km	km	%Length	%Length	%Length	%Length	%Length	%Length
0.290	0.300						
0.300	0.310						
0.310	0.320						
0.320	0.330						
0.330	0.340						
0.340	0.350						
Average		26.9%	33.7%	36.6%	0.0%	0.0%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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Visual Condition Test Report - Surface Defect Plot

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 3A1

Spinifex Street
from Cunningham Street to Sandalwood Street

Road Id: 3
Lane: 1
Block: A

Station Start	Station End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
		%Length	%Length	%Length	%Length	%Length	%Length
0.000	0.010						
0.010	0.020		Isolated	Intermediate			
0.020	0.030		Intermediate				
0.030	0.040		Widespread				
0.040	0.050						
0.050	0.060		Intermediate				
0.060	0.070		Intermediate	Isolated			
0.070	0.080		Isolated				
0.080	0.090		Intermediate				
0.090	0.100		Intermediate				
0.100	0.110						
0.110	0.120						
0.120	0.130			Isolated			
0.130	0.140		Intermediate				
0.140	0.150						
0.150	0.160						
0.160	0.170						
0.170	0.180		Widespread	Isolated			
Average		0.0%	28.9%	6.7%	0.0%	0.0%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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FUGRO PMS

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Visual Condition Test Report - Surface Defect Plot

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 3A2

Spinifex Street
from Sandalwood Street to Cunningham Street

Road Id: 3
Lane: 2
Block: A

Station Start	Station End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
		%Length	%Length	%Length	%Length	%Length	%Length
km	km						
0.000	0.010	██████████					
0.010	0.020	██████████	██████████				
0.020	0.030		██████████	██████████			
0.030	0.040		██████████				
0.040	0.050		██████████	██████████			
0.050	0.060	██████████		██████████			
0.060	0.070			██████████			
0.070	0.080			██████████			
0.080	0.090		██████████	██████████			
0.090	0.100		██████████	██████████			
0.100	0.110	██████████	██████████				
0.110	0.120	██████████	██████████	██████████			
0.120	0.130			██████████			
0.130	0.140		██████████	██████████			
0.140	0.150		██████████	██████████			
0.150	0.160			██████████			
0.160	0.170		██████████	██████████			
0.170	0.180		██████████				
Average		7.8%	27.8%	38.9%	0.0%	0.0%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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FUGRO PMS

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Visual Condition Test Report - Surface Defect Plot

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 4A1

Marri Street
from Cunningham Street to Eurabbie Street

Road Id: 4
Lane: 1
Block: A

Station Start	Station End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
km	km	%Length	%Length	%Length	%Length	%Length	%Length
0.000	0.010						
0.010	0.020		Isolated	Isolated			
0.020	0.030		Intermediate	Widespread			
0.030	0.040		Widespread	Intermediate			
0.040	0.050	Isolated	Isolated	Isolated			
0.050	0.060	Intermediate	Isolated	Intermediate			
0.060	0.070		Isolated	Isolated			
0.070	0.080		Intermediate				
0.080	0.088	Intermediate	Widespread				
Average		14.4%	35.0%	26.7%	0.0%	0.0%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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FUGRO PMS

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Visual Condition Test Report - Surface Defect Plot

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 4A2

Marri Street
from Eurabbie Street to Cunningham Street

Road Id: 4
Lane: 2
Block: A

Station Start	Station End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
km	km	%Length	%Length	%Length	%Length	%Length	%Length
0.000	0.010						
0.010	0.020						
0.020	0.030						
0.030	0.040						
0.040	0.050						
0.050	0.060						
0.060	0.070						
0.070	0.080						
0.080	0.088						
Average		6.7%	56.7%	23.9%	2.8%	0.0%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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FUGRO PMS

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Visual Condition Test Report - Surface Defect Plot

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 5A1

Blueberry Street
from Newcastle Street to The End

Road Id: 5
Lane: 1
Block: A

Station Start	Station End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
		%Length	%Length	%Length	%Length	%Length	%Length
km	km						
0.000	0.010		Widespread				
0.010	0.020		Widespread	Isolated			
0.020	0.030		Widespread	Intermediate			
0.030	0.040		Widespread				
0.040	0.050		Widespread				
0.050	0.060		Widespread				
0.060	0.070		Intermediate	Intermediate			
0.070	0.080		Widespread				
0.080	0.090		Widespread				
0.090	0.100		Widespread	Isolated			
0.100	0.110		Widespread				
0.110	0.120		Widespread	Isolated			
0.120	0.130		Widespread				
0.130	0.140		Widespread				
0.140	0.150						
0.150	0.160	Isolated	Isolated				
0.160	0.170		Intermediate	Intermediate		Isolated	
0.170	0.180		Isolated				
0.180	0.190		Intermediate	Intermediate			
0.190	0.200	Isolated	Isolated				
0.200	0.210	Intermediate	Isolated				
0.210	0.220	Intermediate					
0.220	0.230						
0.230	0.240		Intermediate	Intermediate			
0.240	0.250		Widespread				
0.250	0.260		Widespread				
0.260	0.270		Widespread			Intermediate	
0.270	0.280		Widespread				
0.280	0.290		Intermediate	Intermediate			

Legend: No Occurance: Isolated: Intermediate: Widespread:

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Station		Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
Start	End						
km	km	%Length	%Length	%Length	%Length	%Length	%Length
0.290	0.300						
0.300	0.310						
0.310	0.320						
0.320	0.330						
0.330	0.340						
0.340	0.350						
Average		4.6%	58.3%	9.1%	0.0%	1.7%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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FUGRO PMS

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Visual Condition Test Report - Surface Defect Plot

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 5A2














Blueberry Street
from The End to Newcastle Street

Road Id: 5
Lane: 2
Block: A

Station Start	End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
		%Length	%Length	%Length	%Length	%Length	%Length
0.000	0.010	Widespread	Intermediate	Intermediate	No Occurance	No Occurance	No Occurance
0.010	0.020	Isolated	Intermediate	Intermediate	No Occurance	No Occurance	No Occurance
0.020	0.030	No Occurance	Intermediate	Intermediate	No Occurance	No Occurance	No Occurance
0.030	0.040	No Occurance	Widespread	Isolated	No Occurance	No Occurance	No Occurance
0.040	0.050	No Occurance	Widespread	No Occurance	No Occurance	No Occurance	No Occurance
0.050	0.060	Isolated	Intermediate	No Occurance	No Occurance	No Occurance	No Occurance
0.060	0.070	Intermediate	Intermediate	No Occurance	No Occurance	Intermediate	No Occurance
0.070	0.080	Isolated	No Occurance	No Occurance	No Occurance	Intermediate	No Occurance
0.080	0.090	No Occurance	Intermediate	No Occurance	No Occurance	No Occurance	No Occurance
0.090	0.100	No Occurance	Widespread	No Occurance	No Occurance	No Occurance	No Occurance
0.100	0.110	No Occurance	Widespread	No Occurance	No Occurance	No Occurance	No Occurance
0.110	0.120	No Occurance	Widespread	No Occurance	No Occurance	No Occurance	No Occurance
0.120	0.130	No Occurance	Widespread	No Occurance	No Occurance	No Occurance	No Occurance
0.130	0.140	No Occurance	Widespread	No Occurance	No Occurance	No Occurance	No Occurance
0.140	0.150	No Occurance	Isolated	No Occurance	No Occurance	No Occurance	No Occurance
0.150	0.160	Isolated	Intermediate	No Occurance	No Occurance	No Occurance	No Occurance
0.160	0.170	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance
0.170	0.180	No Occurance	Intermediate	Intermediate	No Occurance	No Occurance	No Occurance
0.180	0.190	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance
0.190	0.200	No Occurance	Isolated	No Occurance	No Occurance	No Occurance	No Occurance
0.200	0.210	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance
0.210	0.220	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance
0.220	0.230	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance
0.230	0.240	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance
0.240	0.250	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance	No Occurance
0.250	0.260	No Occurance	Intermediate	No Occurance	No Occurance	No Occurance	No Occurance
0.260	0.270	No Occurance	Isolated	No Occurance	No Occurance	No Occurance	No Occurance
0.270	0.280	No Occurance	Isolated	No Occurance	No Occurance	No Occurance	No Occurance
0.280	0.290	No Occurance	Isolated	No Occurance	No Occurance	No Occurance	No Occurance

Legend: No Occurance: Isolated: Intermediate: Widespread:

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Station		Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
Start	End						
km	km	%Length	%Length	%Length	%Length	%Length	%Length
0.290	0.300						
0.300	0.310						
0.310	0.320						
0.320	0.330						
0.330	0.340						
0.340	0.350						
Average		9.7%	38.3%	10.3%	2.9%	2.3%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance:  Isolated:  Intermediate:  Widespread: 

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FUGRO PMS

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Visual Condition Test Report - Surface Defect Plot

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 6A1

Eurabbie Street
from Blueberry Street to Spinifex Street

Road Id: 6
Lane: 1
Block: A

Station Start	Station End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
km	km	%Length	%Length	%Length	%Length	%Length	%Length
0.000	0.010		Widespread				
0.010	0.020						
0.020	0.030						
0.030	0.040		Intermediate				
0.040	0.050						
0.050	0.060		Isolated				
0.060	0.070		Intermediate	Intermediate			
0.070	0.080	Isolated	Isolated				
0.080	0.090	Isolated	Intermediate				
0.090	0.100		Intermediate				
0.100	0.110		Intermediate				
0.110	0.120	Isolated	Intermediate				
0.120	0.130		Isolated				
0.130	0.140		Intermediate	Isolated			
0.140	0.150	Isolated	Intermediate				
Average		5.3%	37.3%	4.0%	0.0%	0.0%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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FUGRO PMS

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Visual Condition Test Report - Surface Defect Plot

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 6A2

Eurabbie Street
from Spinifex Street to Blueberry Street

Road Id: 6
Lane: 2
Block: A

Station		Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
Start	End	%Length	%Length	%Length	%Length	%Length	%Length
km	km						
0.000	0.010						
0.010	0.020						
0.020	0.030						
0.030	0.040						
0.040	0.050						
0.050	0.060						
0.060	0.070						
0.070	0.080						
0.080	0.090						
0.090	0.100						
0.100	0.110						
0.110	0.120						
0.120	0.130						
0.130	0.140						
0.140	0.150						
Average		10.7%	26.7%	1.3%	0.0%	0.0%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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FUGRO PMS

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Visual Condition Test Report - Surface Defect Plot

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 7A1

Sandalwood Street
from Blueberry Street to Spinifex Street

Road Id: 7
Lane: 1
Block: A

Station Start	Station End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
		%Length	%Length	%Length	%Length	%Length	%Length
km	km						
0.000	0.010	100%					
0.010	0.020						
0.020	0.030			100%			
0.030	0.040						
0.040	0.050						
0.050	0.060			100%			
0.060	0.070	100%		100%			
0.070	0.080						
0.080	0.090						
0.090	0.100						
0.100	0.110						
0.110	0.120	100%					
0.120	0.130						
0.130	0.140						
0.140	0.150		100%				
0.150	0.160		100%				
0.160	0.170		100%	100%			
0.170	0.180		100%	100%			
0.180	0.190			100%			
0.190	0.200		100%	100%			
0.200	0.210		100%	100%			
0.210	0.220		100%	100%			
0.220	0.230		100%	100%			
Average		4.3%	11.3%	25.2%	0.0%	0.0%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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FUGRO PMS

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Visual Condition Test Report - Surface Defect Plot

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 7A2

Sandalwood Street
from Spinifex Street to Blueberry Street

Road Id: 7
Lane: 2
Block: A

Station Start	Station End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
		%Length	%Length	%Length	%Length	%Length	%Length
km	km						
0.000	0.010	██████████					
0.010	0.020						
0.020	0.030	██████████		██████████			
0.030	0.040						
0.040	0.050	██████████		██████████			
0.050	0.060	██████████		██████████			██████████
0.060	0.070			██████████			
0.070	0.080	██████████					
0.080	0.090						
0.090	0.100						
0.100	0.110	██████████					
0.110	0.120	██████████					
0.120	0.130	██████████					
0.130	0.140	██████████					
0.140	0.150	██████████	██████████			██████████	
0.150	0.160		██████████				
0.160	0.170		██████████	██████████			
0.170	0.180	██████████	██████████	██████████			
0.180	0.190	██████████		██████████			
0.190	0.200		██████████	██████████			
0.200	0.210		██████████	██████████			
0.210	0.220		██████████	██████████			
0.220	0.230	██████████					
Average		26.1%	16.5%	17.4%	0.0%	2.6%	0.9%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Visual Condition Test Report - Surface Defect Plot

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 9A1

Newcastle Street
from Blueberry Street to The End

Road Id: 9
Lane: 1
Block: A

Station Start	End	Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
		%Length	%Length	%Length	%Length	%Length	%Length
0.000	0.010						
0.010	0.020						
0.020	0.030						
0.030	0.040						
0.040	0.050						
0.050	0.060						
0.060	0.070						
0.070	0.080						
0.080	0.090						
0.090	0.100						
0.100	0.110						
0.110	0.120						
0.120	0.130						
0.130	0.140						
Average		8.6%	90.0%	7.1%	4.3%	0.0%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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FUGRO PMS

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Visual Condition Test Report - Surface Defect Plot

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: VR2012080-1
Client Section ID: 9A2

Newcastle Street
from The End to Blueberry Street

Road Id: 9
Lane: 2
Block: A

Station		Aggregate Loss	Environmental Cracking	Fatigue Cracking	Heavy Patch	Irregular Patch	Pothole
Start	End	%Length	%Length	%Length	%Length	%Length	%Length
km	km						
0.000	0.010	██████████	██████████				
0.010	0.020		██████████				
0.020	0.030		██████████				
0.030	0.040		██████████				
0.040	0.050		██████████				
0.050	0.060	██████████	██████████		██████████		
0.060	0.070	██████████	██████████				
0.070	0.080	██████████	██████████				
0.080	0.090	██████████	██████████				
0.090	0.100		██████████				
0.100	0.110	██████████	██████████				
0.110	0.120		██████████				
0.120	0.130		██████████				
0.130	0.140		██████████		██████████		
Average		42.9%	85.7%	0.0%	4.3%	0.0%	0.0%

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

Legend: No Occurance: Isolated: Intermediate: Widespread:

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FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 1A1
Test Run: 1

Cunningham Street
from Wentworth Avenue to Geijera Place

Road Id: 1
Lane: 1
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr	
km	km	mm	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%		
0.000	0.010	8.4	55	10	8	20	8	0	0	0	0	10.4	53	8	3	13	15	10	0	0	0	36.5	Braking/Accelerating
0.010	0.020	13.8	0	25	38	23	13	0	3	0	0	6.3	45	38	10	5	3	0	0	0	0	38.9	Braking/Accelerating
0.020	0.030	8.5	10	54	37	0	0	0	0	0	0	5.1	51	46	0	2	0	0	0	0	0	40.7	
0.030	0.040	3.7	78	22	0	0	0	0	0	0	0	4.0	76	24	0	0	0	0	0	0	0	41.4	
0.040	0.050	6.2	38	55	8	0	0	0	0	0	0	3.3	93	8	0	0	0	0	0	0	0	41.8	
0.050	0.060	9.1	12	44	44	0	0	0	0	0	0	2.2	100	0	0	0	0	0	0	0	0	41.8	
0.060	0.070	5.0	65	25	10	0	0	0	0	0	0	2.2	100	0	0	0	0	0	0	0	0	42.6	
0.070	0.080	5.2	60	38	0	0	0	3	0	0	0	2.7	98	0	0	3	0	0	0	0	0	43.4	
0.080	0.090	9.7	12	39	46	2	0	0	0	0	0	3.0	90	10	0	0	0	0	0	0	0	44.4	
0.090	0.100	12.4	8	33	30	18	13	0	0	0	0	4.2	65	35	0	0	0	0	0	0	0	45.1	
0.100	0.110	8.2	28	28	45	0	0	0	0	0	0	2.2	100	0	0	0	0	0	0	0	0	44.7	
0.110	0.120	3.6	85	12	2	0	0	0	0	0	0	2.5	100	0	0	0	0	0	0	0	0	43.7	
0.120	0.130	9.2	40	15	25	18	3	0	0	0	0	6.7	40	33	28	0	0	0	0	0	0	42.8	
0.130	0.140	15.2	0	7	29	61	2	0	0	0	0	11.4	0	22	76	2	0	0	0	0	0	42.1	
0.140	0.150	14.9	0	0	59	37	5	0	0	0	0	11.4	0	17	78	5	0	0	0	0	0	41.5	
0.150	0.160	18.3	0	0	0	80	18	3	0	0	0	12.5	0	18	65	13	5	0	0	0	0	41.5	
0.160	0.170	13.6	10	15	29	44	2	0	0	0	0	5.5	46	49	5	0	0	0	0	0	0	42.2	
0.170	0.180	4.4	64	28	8	0	0	0	0	0	0	5.4	54	44	3	0	0	0	0	0	0	43.8	
0.180	0.190	1.0	100	0	0	0	0	0	0	0	0	2.5	100	0	0	0	0	0	0	0	0	45.3	
0.190	0.200	1.2	100	0	0	0	0	0	0	0	0	2.1	100	0	0	0	0	0	0	0	0	46.7	
0.200	0.210	1.7	98	3	0	0	0	0	0	0	0	2.6	90	10	0	0	0	0	0	0	0	48.5	
0.210	0.220	1.0	100	0	0	0	0	0	0	0	0	2.0	100	0	0	0	0	0	0	0	0	50.2	

Station		Outer Wheelpath Rut Depth and Bin Results											Inner Wheelpath Rut Depth and Bin Results											Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr			
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%			
0.220	0.230	1.2	100	0	0	0	0	0	0	0	0	1.4	100	0	0	0	0	0	0	0	0	0	51.4		
0.230	0.240	2.4	90	10	0	0	0	0	0	0	0	4.1	56	44	0	0	0	0	0	0	0	0	52.2		
0.240	0.250	2.7	100	0	0	0	0	0	0	0	0	5.7	33	68	0	0	0	0	0	0	0	0	52.8		
0.250	0.260	2.2	100	0	0	0	0	0	0	0	0	2.7	98	2	0	0	0	0	0	0	0	0	53.3		
0.260	0.270	4.5	73	25	3	0	0	0	0	0	0	2.6	100	0	0	0	0	0	0	0	0	0	53.6		
0.270	0.280	3.3	93	5	3	0	0	0	0	0	0	2.6	100	0	0	0	0	0	0	0	0	0	53.3		
0.280	0.290	5.2	54	37	10	0	0	0	0	0	0	3.9	73	27	0	0	0	0	0	0	0	0	53.0		
0.290	0.300	3.1	88	13	0	0	0	0	0	0	0	3.9	80	20	0	0	0	0	0	0	0	0	52.9		
0.300	0.310	3.5	78	23	0	0	0	0	0	0	0	3.6	80	20	0	0	0	0	0	0	0	0	52.9		
0.310	0.320	3.0	98	2	0	0	0	0	0	0	0	4.3	76	24	0	0	0	0	0	0	0	0	53.1		
0.320	0.330	6.0	33	63	5	0	0	0	0	0	0	6.7	28	60	13	0	0	0	0	0	0	0	53.4		
0.330	0.340	3.7	80	20	0	0	0	0	0	0	0	7.7	25	53	23	0	0	0	0	0	0	0	53.6		
0.340	0.350	2.4	100	0	0	0	0	0	0	0	0	4.0	81	20	0	0	0	0	0	0	0	0	53.2		
0.350	0.360	2.9	95	5	0	0	0	0	0	0	0	8.4	8	68	25	0	0	0	0	0	0	0	53.2		
0.360	0.370	2.2	100	0	0	0	0	0	0	0	0	3.4	93	7	0	0	0	0	0	0	0	0	53.6		
0.370	0.380	2.6	100	0	0	0	0	0	0	0	0	4.6	58	43	0	0	0	0	0	0	0	0	54.0		
0.380	0.390	3.3	98	2	0	0	0	0	0	0	0	3.4	100	0	0	0	0	0	0	0	0	0	54.3		
0.390	0.400	3.8	85	15	0	0	0	0	0	0	0	3.9	88	10	3	0	0	0	0	0	0	0	54.2		
0.400	0.410	2.4	100	0	0	0	0	0	0	0	0	2.7	93	7	0	0	0	0	0	0	0	0	54.0		
0.410	0.420	2.0	100	0	0	0	0	0	0	0	0	3.4	85	15	0	0	0	0	0	0	0	0	53.9		
0.420	0.430	2.4	100	0	0	0	0	0	0	0	0	2.5	98	3	0	0	0	0	0	0	0	0	53.8		
0.430	0.440	3.7	95	5	0	0	0	0	0	0	0	5.3	42	59	0	0	0	0	0	0	0	0	53.3		
0.440	0.450	4.6	65	35	0	0	0	0	0	0	0	3.5	98	3	0	0	0	0	0	0	0	0	52.9		
0.450	0.460	4.4	85	15	0	0	0	0	0	0	0	4.3	66	34	0	0	0	0	0	0	0	0	52.3		
0.460	0.470	4.2	73	28	0	0	0	0	0	0	0	3.9	80	20	0	0	0	0	0	0	0	0	51.6		
0.470	0.480	2.9	100	0	0	0	0	0	0	0	0	3.4	88	12	0	0	0	0	0	0	0	0	50.9		
0.480	0.490	3.0	95	5	0	0	0	0	0	0	0	4.7	56	44	0	0	0	0	0	0	0	0	50.2		
0.490	0.500	2.7	100	0	0	0	0	0	0	0	0	4.0	83	17	0	0	0	0	0	0	0	0	49.7		
0.500	0.510	3.7	78	23	0	0	0	0	0	0	0	4.4	70	30	0	0	0	0	0	0	0	0	49.3		
0.510	0.520	3.0	90	10	0	0	0	0	0	0	0	3.5	88	12	0	0	0	0	0	0	0	0	48.9		
0.520	0.530	2.7	100	0	0	0	0	0	0	0	0	3.9	84	16	0	0	0	0	0	0	0	0	48.7		
0.530	0.540	3.2	100	0	0	0	0	0	0	0	0	2.7	100	0	0	0	0	0	0	0	0	0	48.7		
0.540	0.550	2.9	100	0	0	0	0	0	0	0	0	2.7	100	0	0	0	0	0	0	0	0	0	48.8		
0.550	0.560	2.9	100	0	0	0	0	0	0	0	0	2.6	100	0	0	0	0	0	0	0	0	0	48.5		
0.560	0.570	3.9	95	5	0	0	0	0	0	0	0	3.7	90	10	0	0	0	0	0	0	0	0	47.1		
0.570	0.580	3.5	98	2	0	0	0	0	0	0	0	3.4	100	0	0	0	0	0	0	0	0	0	45.2		
0.580	0.590	2.5	100	0	0	0	0	0	0	0	0	2.6	100	0	0	0	0	0	0	0	0	0	42.6		
0.590	0.600	2.7	95	5	0	0	0	0	0	0	0	3.0	98	3	0	0	0	0	0	0	0	0	39.6		
0.600	0.610	3.2	98	2	0	0	0	0	0	0	0	4.3	73	27	0	0	0	0	0	0	0	0	36.8		

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40		
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	km/hr	
0.610	0.620	3.0	100	0	0	0	0	0	0	0	0	5.0	50	50	0	0	0	0	0	0	0	33.6	
0.620	0.630	3.7	88	10	3	0	0	0	0	0	0	4.0	78	23	0	0	0	0	0	0	0	30.7	
0.630	0.640	3.6	88	13	0	0	0	0	0	0	0	3.3	95	5	0	0	0	0	0	0	0	29.9	
0.640	0.650	3.7	83	17	0	0	0	0	0	0	0	4.2	73	27	0	0	0	0	0	0	0	30.1	
Average		4.6	76	13	6	4	1	0	0	0	0	4.1	76	19	5	0	0	0	0	0	0	47.4	
Standard Deviation		3.6										2.2										6.4	
10th Percentile		2.2										2.5											
90th Percentile		9.2										6.5											

Survey Notes

- 1 All station values increase in the Prescribed direction
- 2 The comment for the interval indicates the value may be affected by the events.
- 3 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 Rut depth values determined using a 2m straight edge laid across a 3m lane width

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 1A2
Test Run: 1

Cunningham Street
from Geijera Place to Wentworth Avenue

Road Id: 1
Lane: 2
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr	
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%	
0.000	0.010	3.3	83	12	5	0	0	0	0	0	0	3.1	88	12	0	0	0	0	0	0	0	11.9	Braking/Accelerating
0.010	0.020	2.3	95	5	0	0	0	0	0	0	0	5.0	84	11	0	0	5	0	0	0	0	21.7	Braking/Accelerating
0.020	0.030	2.8	98	0	0	3	0	0	0	0	0	6.5	50	38	8	5	0	0	0	0	0	32.7	
0.030	0.040	5.1	54	46	0	0	0	0	0	0	0	8.2	22	49	27	2	0	0	0	0	0	38.4	
0.040	0.050	29.8	0	30	10	3	10	0	3	3	43	47.7	0	10	0	3	5	5	3	3	73	42.4	
0.050	0.060	58.9	0	0	0	0	0	0	0	0	100	52.9	0	0	0	0	0	0	12	12	76	45.5	
0.060	0.070	14.0	13	33	18	15	5	10	3	5	0	6.0	68	8	15	3	5	3	0	0	0	47.8	
0.070	0.080	2.9	81	17	2	0	0	0	0	0	0	2.4	98	2	0	0	0	0	0	0	0	48.9	
0.080	0.090	1.6	100	0	0	0	0	0	0	0	0	2.9	100	0	0	0	0	0	0	0	0	49.7	
0.090	0.100	1.6	98	3	0	0	0	0	0	0	0	1.9	100	0	0	0	0	0	0	0	0	49.7	
0.100	0.110	1.2	100	0	0	0	0	0	0	0	0	2.3	100	0	0	0	0	0	0	0	0	49.2	
0.110	0.120	1.7	100	0	0	0	0	0	0	0	0	2.8	100	0	0	0	0	0	0	0	0	48.4	
0.120	0.130	3.2	80	20	0	0	0	0	0	0	0	3.8	90	10	0	0	0	0	0	0	0	47.6	
0.130	0.140	1.6	100	0	0	0	0	0	0	0	0	4.4	70	30	0	0	0	0	0	0	0	46.9	
0.140	0.150	1.8	100	0	0	0	0	0	0	0	0	3.7	83	17	0	0	0	0	0	0	0	46.4	
0.150	0.160	1.3	100	0	0	0	0	0	0	0	0	6.2	30	70	0	0	0	0	0	0	0	46.2	
0.160	0.170	1.9	100	0	0	0	0	0	0	0	0	8.4	0	81	20	0	0	0	0	0	0	46.4	
0.170	0.180	1.2	100	0	0	0	0	0	0	0	0	2.8	90	10	0	0	0	0	0	0	0	46.8	
0.180	0.190	1.6	100	0	0	0	0	0	0	0	0	2.7	98	2	0	0	0	0	0	0	0	47.7	
0.190	0.200	1.0	100	0	0	0	0	0	0	0	0	2.1	100	0	0	0	0	0	0	0	0	48.7	
0.200	0.210	1.2	100	0	0	0	0	0	0	0	0	2.2	100	0	0	0	0	0	0	0	0	49.3	
0.210	0.220	1.1	100	0	0	0	0	0	0	0	0	2.6	100	0	0	0	0	0	0	0	0	49.8	

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment	
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr		
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%		
0.220	0.230	0.9	100	0	0	0	0	0	0	0	0	2.6	100	0	0	0	0	0	0	0	0	0	50.5	
0.230	0.240	2.7	100	0	0	0	0	0	0	0	0	3.0	100	0	0	0	0	0	0	0	0	0	51.3	
0.240	0.250	2.2	100	0	0	0	0	0	0	0	0	2.0	100	0	0	0	0	0	0	0	0	0	52.1	
0.250	0.260	2.0	100	0	0	0	0	0	0	0	0	2.0	100	0	0	0	0	0	0	0	0	0	52.7	
0.260	0.270	1.9	100	0	0	0	0	0	0	0	0	1.7	100	0	0	0	0	0	0	0	0	0	52.9	
0.270	0.280	1.6	100	0	0	0	0	0	0	0	0	1.5	100	0	0	0	0	0	0	0	0	0	52.8	
0.280	0.290	1.7	100	0	0	0	0	0	0	0	0	1.8	100	0	0	0	0	0	0	0	0	0	52.3	
0.290	0.300	1.9	100	0	0	0	0	0	0	0	0	2.3	100	0	0	0	0	0	0	0	0	0	51.6	
0.300	0.310	2.5	95	5	0	0	0	0	0	0	0	2.9	90	10	0	0	0	0	0	0	0	0	50.8	
0.310	0.320	3.0	90	10	0	0	0	0	0	0	0	4.5	65	35	0	0	0	0	0	0	0	0	50.4	
0.320	0.330	2.6	100	0	0	0	0	0	0	0	0	5.0	56	44	0	0	0	0	0	0	0	0	50.1	
0.330	0.340	3.9	83	15	3	0	0	0	0	0	0	4.4	65	35	0	0	0	0	0	0	0	0	49.8	
0.340	0.350	4.1	73	27	0	0	0	0	0	0	0	2.1	100	0	0	0	0	0	0	0	0	0	49.4	
0.350	0.360	4.7	63	37	0	0	0	0	0	0	0	2.6	98	2	0	0	0	0	0	0	0	0	49.0	
0.360	0.370	3.8	80	20	0	0	0	0	0	0	0	2.2	100	0	0	0	0	0	0	0	0	0	48.7	
0.370	0.380	3.3	93	8	0	0	0	0	0	0	0	2.5	100	0	0	0	0	0	0	0	0	0	49.1	
0.380	0.390	4.1	78	22	0	0	0	0	0	0	0	2.1	100	0	0	0	0	0	0	0	0	0	49.6	
0.390	0.400	3.4	93	8	0	0	0	0	0	0	0	2.2	100	0	0	0	0	0	0	0	0	0	50.2	
0.400	0.410	3.8	80	20	0	0	0	0	0	0	0	2.1	100	0	0	0	0	0	0	0	0	0	50.5	
0.410	0.420	2.5	100	0	0	0	0	0	0	0	0	2.3	100	0	0	0	0	0	0	0	0	0	50.9	
0.420	0.430	2.6	100	0	0	0	0	0	0	0	0	2.2	100	0	0	0	0	0	0	0	0	0	51.2	
0.430	0.440	3.3	98	2	0	0	0	0	0	0	0	2.9	95	5	0	0	0	0	0	0	0	0	51.3	
0.440	0.450	2.1	100	0	0	0	0	0	0	0	0	2.5	100	0	0	0	0	0	0	0	0	0	51.4	
0.450	0.460	2.2	100	0	0	0	0	0	0	0	0	2.2	100	0	0	0	0	0	0	0	0	0	51.3	
0.460	0.470	2.3	100	0	0	0	0	0	0	0	0	2.1	100	0	0	0	0	0	0	0	0	0	51.0	
0.470	0.480	2.5	98	2	0	0	0	0	0	0	0	3.0	98	2	0	0	0	0	0	0	0	0	50.6	
0.480	0.490	2.6	100	0	0	0	0	0	0	0	0	2.5	100	0	0	0	0	0	0	0	0	0	50.2	
0.490	0.500	3.2	100	0	0	0	0	0	0	0	0	2.4	100	0	0	0	0	0	0	0	0	0	49.8	
0.500	0.510	3.2	98	2	0	0	0	0	0	0	0	2.9	100	0	0	0	0	0	0	0	0	0	49.7	
0.510	0.520	2.5	100	0	0	0	0	0	0	0	0	2.5	100	0	0	0	0	0	0	0	0	0	49.3	
0.520	0.530	3.1	98	3	0	0	0	0	0	0	0	2.3	100	0	0	0	0	0	0	0	0	0	48.8	
0.530	0.540	3.0	98	2	0	0	0	0	0	0	0	2.3	100	0	0	0	0	0	0	0	0	0	48.1	
0.540	0.550	2.9	100	0	0	0	0	0	0	0	0	2.7	100	0	0	0	0	0	0	0	0	0	47.5	
0.550	0.560	3.0	100	0	0	0	0	0	0	0	0	2.5	100	0	0	0	0	0	0	0	0	0	46.7	
0.560	0.570	3.2	98	2	0	0	0	0	0	0	0	2.6	100	0	0	0	0	0	0	0	0	0	45.2	
0.570	0.580	3.4	88	13	0	0	0	0	0	0	0	2.5	100	0	0	0	0	0	0	0	0	0	43.2	
0.580	0.590	2.4	100	0	0	0	0	0	0	0	0	2.0	100	0	0	0	0	0	0	0	0	0	40.4	
0.590	0.600	2.5	100	0	0	0	0	0	0	0	0	2.1	100	0	0	0	0	0	0	0	0	0	37.1	
0.600	0.610	2.1	100	0	0	0	0	0	0	0	0	3.1	90	10	0	0	0	0	0	0	0	0	32.6	

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment	
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr		
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%		
0.610	0.620	3.7	92	8	0	0	0	0	0	0	0	4.7	62	39	0	0	0	0	0	0	0	0	27.4	
0.620	0.630	3.3	82	18	0	0	0	0	0	0	0	3.4	85	15	0	0	0	0	0	0	0	0	24.0	
Average		4.1	90	6	1	0	0	0	0	0	0	4.6	87	9	1	0	0	0	0	0	0	0	47.4	
Standard Deviation		8.1										8.6											5.9	
10th Percentile		1.3										2.0												
90th Percentile		4.1										6.0												

Survey Notes

- 1 All station values increase in the Prescribed direction
- 2 The comment for the interval indicates the value may be affected by the events.
- 3 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 Rut depth values determined using a 2m straight edge laid across a 3m lane width

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 2A1
Test Run: 1

The Causeway
from Cunningham Street to Newcastle Street

Road Id: 2
Lane: 1
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr	
km	km	mm	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%		
0.000	0.010	4.5	67	31	0	3	0	0	0	0	0	4.1	77	23	0	0	0	0	0	0	0	18.7	Braking/Accelerating
0.010	0.020	4.8	58	42	0	0	0	0	0	0	0	3.4	84	16	0	0	0	0	0	0	0	27.0	Braking/Accelerating
0.020	0.030	3.3	97	0	3	0	0	0	0	0	0	3.5	97	3	0	0	0	0	0	0	0	32.5	
0.030	0.040	4.0	82	18	0	0	0	0	0	0	0	3.4	90	10	0	0	0	0	0	0	0	36.0	
0.040	0.050	12.5	8	31	26	26	8	3	0	0	0	3.4	87	13	0	0	0	0	0	0	0	38.9	
0.050	0.060	12.0	16	30	24	16	5	5	3	0	0	3.2	89	11	0	0	0	0	0	0	0	40.7	
0.060	0.070	17.0	8	21	21	21	10	10	5	3	3	2.8	97	0	0	3	0	0	0	0	0	42.3	
0.070	0.080	15.5	5	21	31	23	10	3	3	3	3	2.2	100	0	0	0	0	0	0	0	0	43.6	
0.080	0.090	5.1	66	29	3	0	0	0	0	0	3	2.2	97	3	0	0	0	0	0	0	0	44.4	
0.090	0.100	3.0	92	8	0	0	0	0	0	0	0	4.4	67	28	5	0	0	0	0	0	0	44.9	
0.100	0.110	4.4	68	24	5	3	0	0	0	0	0	3.4	84	16	0	0	0	0	0	0	0	44.7	
0.110	0.120	11.9	31	21	28	5	5	5	3	0	3	6.2	39	59	3	0	0	0	0	0	0	44.1	
0.120	0.130	14.8	21	29	8	11	13	8	0	5	5	6.0	47	32	21	0	0	0	0	0	0	43.0	
0.130	0.140	35.8	0	5	3	11	8	5	21	5	42	5.0	66	26	8	0	0	0	0	0	0	41.6	
0.140	0.150	11.5	21	33	21	10	8	3	5	0	0	3.2	95	5	0	0	0	0	0	0	0	40.3	
0.150	0.160	6.8	39	51	3	5	3	0	0	0	0	2.8	97	3	0	0	0	0	0	0	0	38.2	
0.160	0.170	5.3	61	26	13	0	0	0	0	0	0	2.9	84	16	0	0	0	0	0	0	0	35.1	
0.170	0.180	4.4	56	41	3	0	0	0	0	0	0	3.1	87	10	3	0	0	0	0	0	0	31.6	
0.180	0.190	5.2	41	59	0	0	0	0	0	0	0	6.5	26	74	0	0	0	0	0	0	0	29.9	
0.190	0.200	8.8	53	11	13	16	3	0	5	0	0	4.5	71	26	3	0	0	0	0	0	0	32.1	
0.200	0.210	21.2	10	15	3	26	13	8	8	8	10	9.1	36	31	15	13	3	3	0	0	0	34.6	
0.210	0.220	17.4	0	24	24	26	0	18	5	0	3	11.7	5	26	53	11	5	0	0	0	0	35.4	

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr	
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%	
0.220	0.230	8.6	26	39	33	3	0	0	0	0	0	8.0	13	64	21	3	0	0	0	0	0	35.9	
0.230	0.240	5.1	66	32	3	0	0	0	0	0	0	6.1	37	58	5	0	0	0	0	0	0	36.6	
0.240	0.250	3.8	82	18	0	0	0	0	0	0	0	5.9	39	59	0	3	0	0	0	0	0	37.3	
0.250	0.260	4.5	66	34	0	0	0	0	0	0	0	4.7	55	45	0	0	0	0	0	0	0	38.2	
0.260	0.270	5.8	41	54	3	3	0	0	0	0	0	5.0	59	33	8	0	0	0	0	0	0	39.0	
0.270	0.280	6.0	36	56	8	0	0	0	0	0	0	5.2	46	49	5	0	0	0	0	0	0	39.0	
0.280	0.290	8.0	13	66	18	0	3	0	0	0	0	4.6	68	32	0	0	0	0	0	0	0	38.8	
0.290	0.300	16.8	0	8	41	23	21	0	5	0	3	4.3	77	21	3	0	0	0	0	0	0	37.6	
0.300	0.310	23.8	0	3	29	18	11	8	5	13	13	9.3	26	40	18	11	3	0	3	0	0	34.0	Braking/Accelerating
0.310	0.320	22.4	5	10	15	10	15	18	10	5	10	16.7	13	21	21	13	10	10	5	3	5	25.1	Braking/Accelerating
0.320	0.330	17.7	0	5	15	46	28	5	0	0	0	11.3	0	41	46	10	3	0	0	0	0	18.3	
0.330	0.340	19.8	0	3	16	32	34	11	5	0	0	16.9	0	3	32	42	21	3	0	0	0	20.8	
0.340	0.350	36.2	0	3	5	10	26	13	8	0	36	36.2	0	8	5	10	5	15	8	10	39	16.8	
Average		11.4	36	26	12	10	6	3	2	1	0	6.4	60	26	8	3	1	3	0	0	0	36.5	
Standard Deviation		8.6										6.4										7.2	
10th Percentile		4.0										2.8											
90th Percentile		19.8										11.3											

Survey Notes

- 1 All station values increase in the Prescribed direction
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- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 Rut depth values determined using a 2m straight edge laid across a 3m lane width

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 2A2
Test Run: 1

The Causeway
from Newcastle Street to Cunningham Street

Road Id: 2
Lane: 2
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr	
km	km	mm	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%		
0.000	0.010	4.7	53	45	3	0	0	0	0	0	4.2	63	37	0	0	0	0	0	0	0	0	12.7	Braking/Accelerating
0.010	0.020	9.7	0	73	15	8	5	0	0	0	6.3	25	68	8	0	0	0	0	0	0	0	27.1	
0.020	0.030	9.3	0	63	37	0	0	0	0	0	4.5	74	26	0	0	0	0	0	0	0	0	34.0	
0.030	0.040	10.1	3	56	31	10	0	0	0	0	7.3	28	56	15	0	0	0	0	0	0	0	38.6	
0.040	0.050	19.4	0	14	30	8	24	14	3	3	14.3	0	16	38	38	5	3	0	0	0	0	42.1	
0.050	0.060	15.1	0	15	23	49	13	0	0	0	13.2	0	15	56	26	3	0	0	0	0	0	44.4	
0.060	0.070	16.8	0	0	30	53	18	0	0	0	16.2	0	3	30	58	10	0	0	0	0	0	45.4	
0.070	0.080	12.8	0	18	61	16	5	0	0	0	11.7	0	16	76	8	0	0	0	0	0	0	45.7	
0.080	0.090	21.2	0	10	10	18	31	21	8	3	16.1	0	10	31	36	18	3	3	0	0	0	45.4	
0.090	0.100	12.0	0	23	62	13	3	0	0	0	9.4	0	49	51	0	0	0	0	0	0	0	44.9	
0.100	0.110	7.9	13	74	3	8	3	0	0	0	4.2	62	36	3	0	0	0	0	0	0	0	44.6	
0.110	0.120	7.2	18	72	8	3	0	0	0	0	3.7	74	26	0	0	0	0	0	0	0	0	44.6	
0.120	0.130	12.0	5	32	30	27	5	0	0	0	6.6	43	38	14	5	0	0	0	0	0	0	43.8	
0.130	0.140	9.2	0	74	21	3	3	0	0	0	4.7	56	41	3	0	0	0	0	0	0	0	41.7	
0.140	0.150	8.6	13	54	28	5	0	0	0	0	5.4	51	44	5	0	0	0	0	0	0	0	38.9	
0.150	0.160	8.4	10	56	33	0	0	0	0	0	3.6	85	8	8	0	0	0	0	0	0	0	35.7	
0.160	0.170	3.7	87	13	0	0	0	0	0	0	3.0	90	10	0	0	0	0	0	0	0	0	31.8	
0.170	0.180	4.5	64	36	0	0	0	0	0	0	5.4	44	54	3	0	0	0	0	0	0	0	26.1	
0.180	0.190	5.6	56	31	13	0	0	0	0	0	5.9	49	44	8	0	0	0	0	0	0	0	19.7	
0.190	0.200	14.6	5	40	16	13	16	3	5	3	10.8	37	24	16	5	11	5	3	0	0	0	20.6	
0.200	0.210	26.0	3	8	31	0	0	5	21	23	22.7	21	3	15	3	0	15	31	8	5	28.9		
0.210	0.220	38.9	0	0	0	0	0	8	20	30	35.9	0	0	0	0	3	20	20	30	28	32.4		

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr	
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%	
0.220	0.230	49.8	0	0	3	3	3	3	13	8	68	42.2	0	5	3	0	3	11	11	8	61	34.6	
0.230	0.240	45.9	0	0	0	0	0	0	5	21	74	34.6	0	0	0	0	10	26	10	21	33	36.0	
0.240	0.250	44.3	0	0	0	0	0	0	0	15	85	28.3	0	0	0	0	15	59	21	5	0	35.5	
0.250	0.260	30.9	0	0	0	0	0	46	41	10	3	20.8	0	0	3	33	56	8	0	0	0	34.8	
0.260	0.270	20.5	0	0	13	46	23	8	8	3	0	12.5	15	26	36	8	5	3	8	0	0	34.6	
0.270	0.280	18.4	0	0	23	46	21	10	0	0	0	5.4	44	54	3	0	0	0	0	0	0	33.2	
0.280	0.290	12.2	0	26	50	24	0	0	0	0	0	5.2	45	55	0	0	0	0	0	0	0	30.2	
0.290	0.300	9.7	13	49	28	10	0	0	0	0	0	5.8	49	41	10	0	0	0	0	0	0	26.0	Braking/Accelerating
0.300	0.310	12.6	5	28	31	31	5	0	0	0	0	7.5	31	36	31	3	0	0	0	0	0	23.6	Braking/Accelerating
0.310	0.320	22.4	10	8	21	15	15	3	8	3	18	23.7	5	23	13	15	10	10	8	3	13	23.5	Braking/Accelerating
0.320	0.330	18.7	0	15	21	23	15	13	13	0	0	13.5	3	31	26	23	15	0	3	0	0	23.6	Braking/Accelerating
0.330	0.340	19.3	0	5	16	34	21	21	3	0	0	12.6	0	53	24	5	11	8	0	0	0	19.5	Braking/Accelerating
0.340	0.350	29.6	3	8	10	13	15	5	10	10	28	19.6	3	13	23	23	15	8	13	0	5	12.7	Braking/Accelerating
Average		19.4	3	28	22	14	6	5	5	5	0	14.0	26	25	17	9	5	5	4	3	0	38.2	
Standard Deviation		13.1										11.3										5.9	
10th Percentile		8.5										4.3											
90th Percentile		42.7										32.7											

Survey Notes

- 1 All station values increase in the Prescribed direction
- 2 The comment for the interval indicates the value may be affected by the events.
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Prepared By: Anatoly Trapeznikov

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FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 3A1
Test Run: 1

Spinifex Street
from Cunningham Street to Sandalwood Street

Road Id: 3
Lane: 1
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment	
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr		
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%		
0.000	0.010	3.0	95	5	0	0	0	0	0	0	0	3.3	90	10	0	0	0	0	0	0	0	0	18.4	Braking/Accelerating
0.010	0.020	4.0	75	20	5	0	0	0	0	0	0	3.0	98	3	0	0	0	0	0	0	0	0	24.6	
0.020	0.030	4.8	83	8	8	0	0	0	0	3	0	2.3	98	3	0	0	0	0	0	0	0	0	30.0	
0.030	0.040	6.1	28	70	3	0	0	0	0	0	0	5.2	45	55	0	0	0	0	0	0	0	0	34.5	
0.040	0.050	7.9	23	50	25	3	0	0	0	0	0	8.0	18	63	18	3	0	0	0	0	0	0	37.6	
0.050	0.060	15.5	10	13	35	20	15	0	3	5	0	11.0	5	35	48	10	3	0	0	0	0	0	38.5	
0.060	0.070	5.8	45	48	8	0	0	0	0	0	0	3.5	90	10	0	0	0	0	0	0	0	0	38.7	
0.070	0.080	8.3	0	78	23	0	0	0	0	0	0	7.1	23	70	8	0	0	0	0	0	0	0	38.4	
0.080	0.090	5.8	38	60	3	0	0	0	0	0	0	4.9	63	38	0	0	0	0	0	0	0	0	38.4	
0.090	0.100	14.5	8	40	10	8	18	18	0	0	0	9.9	43	10	20	8	20	0	0	0	0	0	39.0	
0.100	0.110	5.1	48	53	0	0	0	0	0	0	0	2.1	100	0	0	0	0	0	0	0	0	0	40.0	
0.110	0.120	7.6	28	48	20	5	0	0	0	0	0	2.1	100	0	0	0	0	0	0	0	0	0	41.0	
0.120	0.130	8.3	38	38	5	18	3	0	0	0	0	3.9	75	25	0	0	0	0	0	0	0	0	41.5	
0.130	0.140	6.4	25	73	3	0	0	0	0	0	0	2.4	98	3	0	0	0	0	0	0	0	0	41.2	
0.140	0.150	6.1	45	48	8	0	0	0	0	0	0	2.7	93	8	0	0	0	0	0	0	0	0	39.2	
0.150	0.160	4.9	53	48	0	0	0	0	0	0	0	2.0	100	0	0	0	0	0	0	0	0	0	35.6	
0.160	0.170	6.9	58	28	10	0	3	0	0	0	3	2.3	98	3	0	0	0	0	0	0	0	0	29.4	
0.170	0.180	7.4	40	43	8	8	0	3	0	0	0	7.7	35	33	23	10	0	0	0	0	0	0	15.3	Braking/Accelerating

Average	7.4	38	45	10	3	2	1	0	0	0	4.5	71	20	6	1	1	1	0	0	0	36.7
Standard Deviation	3.2										2.9										4.8
10th Percentile	4.9										2.1										
90th Percentile	11.4										8.9										

Survey Notes

- 1 All station values increase in the Prescribed direction
- 2 The comment for the interval indicates the value may be affected by the events.
- 3 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 Rut depth values determined using a 2m straight edge laid across a 3m lane width

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 3A2
Test Run: 1

Spinifex Street
from Sandalwood Street to Cunningham Street

Road Id: 3
Lane: 2
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment	
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr		
km	km	mm	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%			
0.000	0.010	4.0	93	8	0	0	0	0	0	0	0	3.0	93	8	0	0	0	0	0	0	0	0	17.4	Braking/Accelerating
0.010	0.020	5.4	55	43	0	3	0	0	0	0	0	4.6	65	35	0	0	0	0	0	0	0	0	26.1	
0.020	0.030	11.8	38	20	5	20	10	0	5	0	3	3.9	78	18	5	0	0	0	0	0	0	0	31.1	
0.030	0.040	12.5	0	45	28	18	3	5	3	0	0	6.3	25	73	3	0	0	0	0	0	0	0	34.9	
0.040	0.050	9.6	42	17	22	7	5	7	0	0	0	5.3	54	37	10	0	0	0	0	0	0	0	37.5	
0.050	0.060	3.3	95	3	0	0	0	3	0	0	0	4.1	66	34	0	0	0	0	0	0	0	0	38.5	
0.060	0.070	2.8	98	2	0	0	0	0	0	0	0	3.1	85	12	2	0	0	0	0	0	0	0	38.1	
0.070	0.080	3.3	100	0	0	0	0	0	0	0	0	3.9	70	25	5	0	0	0	0	0	0	0	36.6	
0.080	0.090	3.8	87	13	0	0	0	0	0	0	0	1.8	97	3	0	0	0	0	0	0	0	0	35.1	
0.090	0.100	11.9	2	22	56	20	0	0	0	0	0	6.7	32	54	12	2	0	0	0	0	0	0	34.3	
0.100	0.110	7.3	49	18	21	13	0	0	0	0	0	2.3	92	8	0	0	0	0	0	0	0	0	34.0	
0.110	0.120	8.3	18	48	35	0	0	0	0	0	0	5.0	60	35	5	0	0	0	0	0	0	0	34.6	
0.120	0.130	14.1	0	15	46	37	2	0	0	0	0	7.4	29	49	22	0	0	0	0	0	0	0	34.9	
0.130	0.140	16.8	0	5	30	43	18	5	0	0	0	11.9	15	15	48	15	8	0	0	0	0	0	34.6	
0.140	0.150	7.0	26	54	15	5	0	0	0	0	0	3.8	80	8	13	0	0	0	0	0	0	0	32.3	
0.150	0.160	6.0	22	78	0	0	0	0	0	0	0	3.9	71	22	7	0	0	0	0	0	0	0	29.1	
0.160	0.170	13.3	3	31	31	26	8	3	0	0	0	6.4	51	31	18	0	0	0	0	0	0	0	23.5	
0.170	0.180	7.5	33	45	18	5	0	0	0	0	0	5.8	40	55	5	0	0	0	0	0	0	0	17.7	Braking/Accelerating

Average	8.3	42	25	17	11	2	1	1	0	0	4.9	61	28	9	1	1	1	0	0	0	34.1
Standard Deviation	4.4										2.5										3.4
10th Percentile	3.3										2.6										
90th Percentile	13.5										7.1										

Survey Notes

- 1 All station values increase in the Prescribed direction
- 2 The comment for the interval indicates the value may be affected by the events.
- 3 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 Rut depth values determined using a 2m straight edge laid across a 3m lane width

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 4A1
Test Run: 1

Marri Street
from Cunningham Street to Eurabbie Street

Road Id: 4
Lane: 1
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr	
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%		
0.000	0.010	3.3	91	9	0	0	0	0	0	0	0	3.7	84	16	0	0	0	0	0	0	0	19.9	Braking/Accelerating
0.010	0.020	3.4	91	9	0	0	0	0	0	0	0	3.3	86	14	0	0	0	0	0	0	0	24.0	Braking/Accelerating
0.020	0.030	3.0	91	9	0	0	0	0	0	0	0	3.1	96	5	0	0	0	0	0	0	0	29.4	
0.030	0.040	10.7	7	39	43	5	5	2	0	0	0	5.0	64	25	11	0	0	0	0	0	0	34.1	
0.040	0.050	5.1	52	48	0	0	0	0	0	0	0	4.0	66	34	0	0	0	0	0	0	0	37.0	
0.050	0.060	9.9	21	44	14	9	7	0	5	0	0	2.3	100	0	0	0	0	0	0	0	0	36.8	
0.060	0.070	7.7	52	27	7	9	0	2	0	2	0	3.4	86	14	0	0	0	0	0	0	0	33.2	
0.070	0.080	10.4	30	46	5	9	5	2	2	0	2	4.5	80	9	7	5	0	0	0	0	0	26.6	Braking/Accelerating
0.080	0.088	38.2	0	31	20	9	6	0	0	0	34	16.3	14	17	26	20	3	9	3	0	9	14.3	Braking/Accelerating
Average		7.3	45	33	13	5	2	1	1	0	0	3.6	82	15	2	0	0	1	0	0	0	34.1	
Standard Deviation		3.2										1.0										3.1	
10th Percentile		3.8										2.6											
90th Percentile		10.4										4.6											

Survey Notes

- 1 All station values increase in the Prescribed direction
- 2 The comment for the interval indicates the value may be affected by the events.
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- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 Rut depth values determined using a 2m straight edge laid across a 3m lane width



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 4A2
Test Run: 1

Marri Street
from Eurabbie Street to Cunningham Street

Road Id: 4
Lane: 2
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr	
km	km	mm	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%		
0.000	0.010	25.2	16	44	9	0	9	2	2	0	16	8.2	44	35	7	2	5	7	0	0	0	19.0	Braking/Accelerating
0.010	0.020	3.6	88	10	2	0	0	0	0	0	0	3.3	91	10	0	0	0	0	0	0	0	30.0	
0.020	0.030	5.6	58	30	9	0	2	0	0	0	0	5.2	58	40	2	0	0	0	0	0	0	34.5	
0.030	0.040	13.9	0	21	38	29	10	2	0	0	0	14.2	0	19	38	33	10	0	0	0	0	36.3	
0.040	0.050	12.1	5	29	45	14	7	0	0	0	0	9.2	0	69	31	0	0	0	0	0	0	36.4	
0.050	0.060	13.2	2	21	41	36	0	0	0	0	0	11.7	17	14	45	24	0	0	0	0	0	33.9	
0.060	0.070	6.6	21	79	0	0	0	0	0	0	0	4.6	58	42	0	0	0	0	0	0	0	28.5	Braking/Accelerating
0.070	0.080	6.9	17	76	5	2	0	0	0	0	0	7.7	29	45	24	2	0	0	0	0	0	21.7	Braking/Accelerating
0.080	0.088	4.5	71	27	3	0	0	0	0	0	0	4.3	65	35	0	0	0	0	0	0	0	16.6	Braking/Accelerating
Average		9.7	31	22	27	16	4	0	0	0	16	8.7	33	30	23	11	2	0	0	0	0	34.2	
Standard Deviation		4.7										4.5										2.6	
10th Percentile		4.4										4.1											
90th Percentile		13.6										13.2											

Survey Notes

- All station values increase in the Prescribed direction
- The comment for the interval indicates the value may be affected by the events.
- The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction
- Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- Rut depth values determined using a 2m straight edge laid across a 3m lane width



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 5A1
Test Run: 1

Blueberry Street
from Newcastle Street to The End

Road Id: 5
Lane: 1
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment	
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr		
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%		
0.000	0.010	3.6	78	18	5	0	0	0	0	0	0	2.8	93	8	0	0	0	0	0	0	0	0	17.1	Braking/Accelerating
0.010	0.020	4.2	68	30	3	0	0	0	0	0	0	4.2	73	25	3	0	0	0	0	0	0	0	28.9	Braking/Accelerating
0.020	0.030	2.3	100	0	0	0	0	0	0	0	0	2.7	93	8	0	0	0	0	0	0	0	0	34.7	
0.030	0.040	3.7	72	28	0	0	0	0	0	0	0	2.9	85	15	0	0	0	0	0	0	0	0	38.1	
0.040	0.050	3.4	88	13	0	0	0	0	0	0	0	3.3	85	13	3	0	0	0	0	0	0	0	41.1	
0.050	0.060	3.3	90	10	0	0	0	0	0	0	0	2.2	100	0	0	0	0	0	0	0	0	0	43.4	
0.060	0.070	2.4	98	3	0	0	0	0	0	0	0	1.7	100	0	0	0	0	0	0	0	0	0	44.8	
0.070	0.080	3.8	72	28	0	0	0	0	0	0	0	2.5	90	10	0	0	0	0	0	0	0	0	45.9	
0.080	0.090	6.5	39	44	17	0	0	0	0	0	0	6.3	39	42	20	0	0	0	0	0	0	0	46.5	
0.090	0.100	5.5	51	44	5	0	0	0	0	0	0	1.9	100	0	0	0	0	0	0	0	0	0	46.3	
0.100	0.110	6.2	40	58	3	0	0	0	0	0	0	2.5	95	5	0	0	0	0	0	0	0	0	45.9	
0.110	0.120	3.1	88	13	0	0	0	0	0	0	0	3.0	93	8	0	0	0	0	0	0	0	0	45.1	
0.120	0.130	4.3	70	30	0	0	0	0	0	0	0	3.1	83	18	0	0	0	0	0	0	0	0	43.9	
0.130	0.140	5.2	60	25	15	0	0	0	0	0	0	3.9	68	30	3	0	0	0	0	0	0	0	42.4	
0.140	0.150	2.4	100	0	0	0	0	0	0	0	0	2.0	98	2	0	0	0	0	0	0	0	0	40.7	
0.150	0.160	3.8	73	25	3	0	0	0	0	0	0	3.8	73	23	5	0	0	0	0	0	0	0	39.6	
0.160	0.170	6.6	45	30	20	5	0	0	0	0	0	2.9	90	10	0	0	0	0	0	0	0	0	39.2	
0.170	0.180	3.7	78	20	3	0	0	0	0	0	0	2.7	98	3	0	0	0	0	0	0	0	0	39.2	
0.180	0.190	2.6	98	3	0	0	0	0	0	0	0	2.6	98	3	0	0	0	0	0	0	0	0	39.9	
0.190	0.200	2.0	100	0	0	0	0	0	0	0	0	2.1	98	3	0	0	0	0	0	0	0	0	40.6	
0.200	0.210	3.1	90	10	0	0	0	0	0	0	0	1.9	100	0	0	0	0	0	0	0	0	0	41.5	
0.210	0.220	3.6	88	13	0	0	0	0	0	0	0	2.2	98	3	0	0	0	0	0	0	0	0	42.2	

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment	
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr		
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%		
0.220	0.230	4.1	85	13	3	0	0	0	0	0	0	2.0	100	0	0	0	0	0	0	0	0	0	42.4	
0.230	0.240	4.5	67	33	0	0	0	0	0	0	0	2.1	97	3	0	0	0	0	0	0	0	0	42.3	
0.240	0.250	4.0	78	23	0	0	0	0	0	0	0	2.4	98	0	3	0	0	0	0	0	0	0	42.0	
0.250	0.260	6.3	39	54	5	2	0	0	0	0	0	2.7	93	7	0	0	0	0	0	0	0	0	41.7	
0.260	0.270	4.6	58	43	0	0	0	0	0	0	0	2.4	95	5	0	0	0	0	0	0	0	0	41.6	
0.270	0.280	5.0	53	45	3	0	0	0	0	0	0	2.6	95	5	0	0	0	0	0	0	0	0	41.6	
0.280	0.290	4.0	80	21	0	0	0	0	0	0	0	3.7	87	13	0	0	0	0	0	0	0	0	41.6	
0.290	0.300	2.2	100	0	0	0	0	0	0	0	0	2.2	97	3	0	0	0	0	0	0	0	0	41.4	
0.300	0.310	3.2	98	3	0	0	0	0	0	0	0	2.8	95	5	0	0	0	0	0	0	0	0	40.5	
0.310	0.320	3.3	98	3	0	0	0	0	0	0	0	3.0	100	0	0	0	0	0	0	0	0	0	38.5	
0.320	0.330	2.9	95	5	0	0	0	0	0	0	0	2.5	98	3	0	0	0	0	0	0	0	0	34.1	
0.330	0.340	18.6	63	12	5	0	0	0	0	0	20	7.6	73	5	10	0	2	2	2	0	5	27.1		
0.340	0.350	11.5	64	20	0	4	0	0	0	0	12	5.1	88	4	0	4	0	0	4	0	0	13.9		
Average		4.6	76	20	2	0	0	0	0	0	0	2.9	91	7	1	0	0	0	0	0	0	0	40.3	
Standard Deviation		3.1										1.3											6.1	
10th Percentile		2.4										2.0												
90th Percentile		6.5										3.9												

Survey Notes

- 1 All station values increase in the Prescribed direction
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- 3 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 Rut depth values determined using a 2m straight edge laid across a 3m lane width

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 5A2
Test Run: 1

Blueberry Street
from The End to Newcastle Street

Road Id: 5
Lane: 2
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr	
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%	
0.000	0.010	11.7	33	40	0	3	0	23	3	0	0	6.5	48	30	20	3	0	0	0	0	0	28.9	
0.010	0.020	29.9	0	0	0	0	3	48	48	3	0	10.2	23	15	58	0	5	0	0	0	0	35.3	
0.020	0.030	10.9	21	59	0	3	5	5	8	0	0	9.8	13	33	44	10	0	0	0	0	0	40.1	
0.030	0.040	6.2	38	45	15	3	0	0	0	0	0	9.2	5	63	20	13	0	0	0	0	0	44.1	
0.040	0.050	9.6	0	65	35	0	0	0	0	0	0	5.7	43	50	8	0	0	0	0	0	0	46.9	
0.050	0.060	10.1	0	54	41	5	0	0	0	0	0	3.8	78	16	5	0	0	0	0	0	0	48.4	
0.060	0.070	12.9	18	38	3	10	33	0	0	0	0	6.6	40	43	18	0	0	0	0	0	0	48.8	
0.070	0.080	13.7	0	13	43	45	0	0	0	0	0	3.0	93	8	0	0	0	0	0	0	0	48.9	
0.080	0.090	13.7	5	23	33	30	0	10	0	0	0	6.3	28	65	8	0	0	0	0	0	0	48.9	
0.090	0.100	10.6	3	47	44	0	3	3	0	0	0	5.5	42	56	3	0	0	0	0	0	0	48.3	
0.100	0.110	11.8	3	15	68	15	0	0	0	0	0	10.5	3	43	45	10	0	0	0	0	0	47.7	
0.110	0.120	10.6	18	28	28	28	0	0	0	0	0	9.1	0	75	25	0	0	0	0	0	0	47.2	
0.120	0.130	3.6	90	10	0	0	0	0	0	0	0	7.3	23	58	20	0	0	0	0	0	0	46.1	
0.130	0.140	3.1	92	8	0	0	0	0	0	0	0	5.6	39	62	0	0	0	0	0	0	0	45.1	
0.140	0.150	4.5	65	33	3	0	0	0	0	0	0	2.9	85	13	3	0	0	0	0	0	0	43.6	
0.150	0.160	4.6	85	10	0	3	0	0	3	0	0	5.8	44	51	5	0	0	0	0	0	0	41.7	
0.160	0.170	6.8	30	65	0	0	0	5	0	0	0	4.1	75	23	3	0	0	0	0	0	0	39.3	
0.170	0.180	3.3	88	13	0	0	0	0	0	0	0	2.8	95	5	0	0	0	0	0	0	0	36.9	
0.180	0.190	4.7	49	49	3	0	0	0	0	0	0	4.3	69	31	0	0	0	0	0	0	0	35.7	
0.190	0.200	13.4	13	33	18	15	10	10	0	3	0	9.1	33	30	20	18	0	0	0	0	0	35.9	
0.200	0.210	14.0	0	26	39	18	15	3	0	0	0	9.6	18	44	23	10	5	0	0	0	0	38.1	
0.210	0.220	10.2	5	50	28	15	3	0	0	0	0	4.9	58	40	3	0	0	0	0	0	0	39.9	

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr	
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%	
0.220	0.230	16.9	0	5	28	46	18	3	0	0	0	10.1	3	51	41	5	0	0	0	0	0	39.8	
0.230	0.240	12.7	3	36	39	13	5	5	0	0	0	6.8	21	69	10	0	0	0	0	0	0	38.7	
0.240	0.250	11.7	3	39	31	26	3	0	0	0	0	7.5	21	62	18	0	0	0	0	0	0	37.7	
0.250	0.260	8.2	53	15	15	8	8	3	0	0	0	4.4	70	25	5	0	0	0	0	0	0	36.2	
0.260	0.270	4.4	74	24	0	3	0	0	0	0	0	5.4	61	24	16	0	0	0	0	0	0	34.3	
0.270	0.280	4.1	70	28	3	0	0	0	0	0	0	2.3	95	5	0	0	0	0	0	0	0	32.3	
0.280	0.290	3.0	100	0	0	0	0	0	0	0	0	3.6	77	23	0	0	0	0	0	0	0	31.1	
0.290	0.300	2.3	98	2	0	0	0	0	0	0	0	3.0	90	10	0	0	0	0	0	0	0	30.4	
0.300	0.310	4.6	74	21	3	3	0	0	0	0	0	2.2	100	0	0	0	0	0	0	0	0	31.6	
0.310	0.320	3.0	95	5	0	0	0	0	0	0	0	2.5	93	8	0	0	0	0	0	0	0	31.9	
0.320	0.330	6.6	43	40	10	5	3	0	0	0	0	2.4	100	0	0	0	0	0	0	0	0	30.6	
0.330	0.340	12.5	10	23	39	15	8	5	0	0	0	3.0	95	5	0	0	0	0	0	0	0	25.3	Braking/Accelerating
0.340	0.350	3.7	80	18	3	0	0	0	0	0	0	4.2	65	35	0	0	0	0	0	0	0	15.3	Braking/Accelerating
Average		9.0	38	28	16	9	3	4	2	0	0	5.8	51	34	13	2	0	4	0	0	0	39.7	
Standard Deviation		5.6										2.7										6.5	
10th Percentile		3.1										2.6											
90th Percentile		13.7										9.8											

Survey Notes

- 1 All station values increase in the Prescribed direction
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- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 Rut depth values determined using a 2m straight edge laid across a 3m lane width

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 6A1
Test Run: 1

Eurabbie Street
from Blueberry Street to Spinifex Street

Road Id: 6
Lane: 1
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment		
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr			
km	km	mm	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%				
0.000	0.010	8.8	29	49	7	10	0	0	2	0	2	4.8	56	42	2	0	0	0	0	0	0	15.4	Braking/Accelerating		
0.010	0.020	7.4	7	83	10	0	0	0	0	0	0	4.6	59	42	0	0	0	0	0	0	0	24.6			
0.020	0.030	10.1	20	34	27	17	2	0	0	0	0	3.8	81	20	0	0	0	0	0	0	0	30.7			
0.030	0.040	7.2	26	57	12	5	0	0	0	0	0	3.6	91	7	2	0	0	0	0	0	0	33.2			
0.040	0.050	10.7	37	29	12	2	7	7	2	2	0	5.7	61	12	27	0	0	0	0	0	0	33.6			
0.050	0.060	27.4	0	5	27	7	15	15	2	5	24	13.7	0	27	42	15	10	7	0	0	0	33.7			
0.060	0.070	12.8	17	22	17	29	10	5	0	0	0	7.6	39	46	7	2	0	0	5	0	0	33.9			
0.070	0.080	8.7	10	54	37	0	0	0	0	0	0	6.8	34	51	15	0	0	0	0	0	0	34.0			
0.080	0.090	8.8	22	49	20	5	5	0	0	0	0	5.0	61	37	2	0	0	0	0	0	0	34.3			
0.090	0.100	7.7	7	78	15	0	0	0	0	0	0	6.5	24	76	0	0	0	0	0	0	0	34.8			
0.100	0.110	15.9	0	26	29	17	17	7	2	0	2	12.4	0	38	33	21	7	0	0	0	0	34.8			
0.110	0.120	9.2	0	71	22	7	0	0	0	0	0	7.6	7	78	10	5	0	0	0	0	0	34.3			
0.120	0.130	8.1	5	66	27	2	0	0	0	0	0	7.2	15	61	24	0	0	0	0	0	0	32.8			
0.130	0.140	19.2	0	0	17	34	44	5	0	0	0	16.9	0	0	42	32	24	2	0	0	0	28.1			
0.140	0.150	18.3	2	39	20	2	10	17	0	2	7	15.8	10	27	10	20	7	24	2	0	0	16.7	Braking/Accelerating		
Average		11.8	12	44	21	10	8	3	1	1	2	7.8	36	38	16	6	3	3	0	0	0	32.5			
Standard Deviation		5.9											4.1											3.0	
10th Percentile		7.5											4.0												
90th Percentile		18.5											13.4												

Survey Notes

- 1 All station values increase in the Prescribed direction
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- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 Rut depth values determined using a 2m straight edge laid across a 3m lane width

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 6A2
Test Run: 1

Eurabbie Street
from Spinifex Street to Blueberry Street

Road Id: 6
Lane: 2
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment		
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr			
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%			
0.000	0.010	4.7	68	25	8	0	0	0	0	0	0	3.3	88	13	0	0	0	0	0	0	0	0	24.4		
0.010	0.020	3.9	70	28	0	3	0	0	0	0	0	2.5	95	5	0	0	0	0	0	0	0	0	33.0		
0.020	0.030	4.1	71	27	2	0	0	0	0	0	0	2.1	95	5	0	0	0	0	0	0	0	0	35.8		
0.030	0.040	7.4	43	35	13	5	3	3	0	0	0	4.3	70	15	13	3	0	0	0	0	0	0	37.0		
0.040	0.050	2.5	90	10	0	0	0	0	0	0	0	2.7	85	15	0	0	0	0	0	0	0	0	37.7		
0.050	0.060	5.3	70	8	20	3	0	0	0	0	0	3.5	95	3	0	3	0	0	0	0	0	0	37.7		
0.060	0.070	5.0	71	20	10	0	0	0	0	0	0	3.5	81	20	0	0	0	0	0	0	0	0	37.5		
0.070	0.080	5.1	61	29	10	0	0	0	0	0	0	4.1	73	27	0	0	0	0	0	0	0	0	37.5		
0.080	0.090	4.6	70	20	10	0	0	0	0	0	0	2.1	100	0	0	0	0	0	0	0	0	0	37.7		
0.090	0.100	2.4	100	0	0	0	0	0	0	0	0	2.2	98	3	0	0	0	0	0	0	0	0	37.7		
0.100	0.110	7.7	29	46	24	0	0	0	0	0	0	2.0	95	5	0	0	0	0	0	0	0	0	37.1		
0.110	0.120	9.6	3	79	11	0	3	3	3	0	0	3.5	87	8	3	3	0	0	0	0	0	0	35.8		
0.120	0.130	16.5	0	18	35	5	38	5	0	0	0	6.7	30	50	20	0	0	0	0	0	0	0	33.0		
0.130	0.140	24.9	0	0	0	3	65	28	5	0	0	17.3	0	3	33	35	30	0	0	0	0	0	26.9	Braking/Accelerating	
0.140	0.150	11.2	33	20	13	15	18	3	0	0	0	8.7	45	20	10	15	10	0	0	0	0	0	17.3	Braking/Accelerating	
Average		6.1	57	26	11	1	3	1	0	0	0	3.3	84	13	3	1	0	1	0	0	0	0	35.5		
Standard Deviation		3.7										1.3											3.7		
10th Percentile		2.8										2.1													
90th Percentile		9.2										4.3													

Survey Notes

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Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 7A1
Test Run: 1

Sandalwood Street
from Blueberry Street to Spinifex Street

Road Id: 7
Lane: 1
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment	
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr		
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%		
0.000	0.010	3.2	90	10	0	0	0	0	0	0	0	3.2	90	10	0	0	0	0	0	0	0	0	18.6	Braking/Accelerating
0.010	0.020	6.4	30	60	10	0	0	0	0	0	0	5.1	70	20	5	5	0	0	0	0	0	0	27.5	Braking/Accelerating
0.020	0.030	7.4	21	62	14	2	0	0	0	0	0	3.9	88	12	0	0	0	0	0	0	0	0	34.2	
0.030	0.040	8.5	29	49	12	2	7	0	0	0	0	4.2	76	24	0	0	0	0	0	0	0	0	38.6	
0.040	0.050	10.2	12	46	27	10	2	0	2	0	0	3.3	90	10	0	0	0	0	0	0	0	0	41.6	
0.050	0.060	11.1	18	40	25	8	3	5	0	0	3	4.1	73	25	3	0	0	0	0	0	0	0	43.2	
0.060	0.070	7.8	12	69	19	0	0	0	0	0	0	4.4	67	33	0	0	0	0	0	0	0	0	43.5	
0.070	0.080	5.0	78	15	3	3	0	0	3	0	0	3.3	85	15	0	0	0	0	0	0	0	0	43.6	
0.080	0.090	2.6	98	3	0	0	0	0	0	0	0	2.2	100	0	0	0	0	0	0	0	0	0	44.3	
0.090	0.100	2.7	98	2	0	0	0	0	0	0	0	2.9	100	0	0	0	0	0	0	0	0	0	45.2	
0.100	0.110	3.5	90	10	0	0	0	0	0	0	0	2.7	98	2	0	0	0	0	0	0	0	0	45.6	
0.110	0.120	5.0	54	42	5	0	0	0	0	0	0	4.6	61	37	2	0	0	0	0	0	0	0	45.4	
0.120	0.130	3.7	93	7	0	0	0	0	0	0	0	4.0	73	27	0	0	0	0	0	0	0	0	44.9	
0.130	0.140	3.0	88	12	0	0	0	0	0	0	0	4.0	88	12	0	0	0	0	0	0	0	0	44.5	
0.140	0.150	6.7	61	24	2	10	0	2	0	0	0	3.8	83	17	0	0	0	0	0	0	0	0	44.2	
0.150	0.160	9.4	22	34	29	15	0	0	0	0	0	8.1	32	39	22	7	0	0	0	0	0	0	44.0	
0.160	0.170	8.3	10	63	20	7	0	0	0	0	0	6.6	34	42	22	2	0	0	0	0	0	0	44.8	
0.170	0.180	6.2	38	60	0	3	0	0	0	0	0	5.1	65	30	5	0	0	0	0	0	0	0	45.5	
0.180	0.190	5.6	56	39	5	0	0	0	0	0	0	4.0	76	24	0	0	0	0	0	0	0	0	45.9	
0.190	0.200	5.7	39	56	5	0	0	0	0	0	0	4.5	71	29	0	0	0	0	0	0	0	0	44.5	
0.200	0.210	5.5	38	60	3	0	0	0	0	0	0	7.2	13	83	5	0	0	0	0	0	0	0	41.8	
0.210	0.220	7.7	5	76	19	0	0	0	0	0	0	7.4	10	83	7	0	0	0	0	0	0	0	37.7	

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40		
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	km/hr	
0.220	0.230	8.4	38	43	5	3	10	0	3	0	0	6.6	50	38	5	5	3	0	0	0	0	32.7	Braking/Accelerating
Average		6.3	48	38	9	3	1	0	0	0	0	4.5	69	27	3	0	0	0	0	0	0	43.2	
Standard Deviation		2.5										1.6										3.0	
10th Percentile		3.0										2.9											
90th Percentile		9.5										7.2											

Survey Notes

- 1 All station values increase in the Prescribed direction
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Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 7A2
Test Run: 1

Sandalwood Street
from Spinifex Street to Blueberry Street

Road Id: 7
Lane: 2
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment	
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr		
km	km	mm	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%			
0.000	0.010	5.8	34	59	7	0	0	0	0	0	0	5.4	34	66	0	0	0	0	0	0	0	0	27.0	Braking/Accelerating
0.010	0.020	3.7	95	5	0	0	0	0	0	0	0	5.7	42	56	2	0	0	0	0	0	0	0	35.1	
0.020	0.030	5.4	33	68	0	0	0	0	0	0	0	7.1	8	83	5	5	0	0	0	0	0	0	40.3	
0.030	0.040	7.4	5	78	17	0	0	0	0	0	0	5.8	32	68	0	0	0	0	0	0	0	0	43.6	
0.040	0.050	5.5	37	61	2	0	0	0	0	0	0	5.1	54	44	0	2	0	0	0	0	0	0	45.3	
0.050	0.060	4.3	78	17	2	2	0	0	0	0	0	5.7	39	56	5	0	0	0	0	0	0	0	46.5	
0.060	0.070	6.4	43	48	8	0	0	0	3	0	0	3.1	90	10	0	0	0	0	0	0	0	0	47.1	
0.070	0.080	3.9	81	19	0	0	0	0	0	0	0	3.2	88	12	0	0	0	0	0	0	0	0	47.7	
0.080	0.090	3.5	83	18	0	0	0	0	0	0	0	2.3	100	0	0	0	0	0	0	0	0	0	47.6	
0.090	0.100	5.0	81	10	5	5	0	0	0	0	0	3.5	88	12	0	0	0	0	0	0	0	0	47.1	
0.100	0.110	4.4	83	18	0	0	0	0	0	0	0	4.2	83	18	0	0	0	0	0	0	0	0	46.6	
0.110	0.120	4.3	66	34	0	0	0	0	0	0	0	3.8	95	5	0	0	0	0	0	0	0	0	46.0	
0.120	0.130	5.2	39	61	0	0	0	0	0	0	0	4.3	81	20	0	0	0	0	0	0	0	0	45.1	
0.130	0.140	6.3	68	12	10	10	0	0	0	0	0	3.5	90	10	0	0	0	0	0	0	0	0	44.9	
0.140	0.150	8.9	25	43	20	10	3	0	0	0	0	6.8	30	58	13	0	0	0	0	0	0	0	44.5	
0.150	0.160	11.0	13	38	20	28	3	0	0	0	0	3.7	85	15	0	0	0	0	0	0	0	0	44.7	
0.160	0.170	16.3	0	15	31	33	13	5	3	0	0	5.0	59	36	5	0	0	0	0	0	0	0	44.8	
0.170	0.180	23.5	0	0	15	27	27	7	15	0	10	7.5	2	90	7	0	0	0	0	0	0	0	44.3	
0.180	0.190	21.8	0	0	17	12	49	20	0	2	0	18.2	0	2	17	46	29	5	0	0	0	0	44.2	
0.190	0.200	11.0	49	15	2	15	7	7	5	0	0	7.9	63	2	5	22	7	0	0	0	0	0	43.6	
0.200	0.210	7.0	54	32	5	2	5	0	2	0	0	5.0	46	54	0	0	0	0	0	0	0	0	42.1	
0.210	0.220	7.3	48	33	15	3	0	0	0	3	0	3.6	80	20	0	0	0	0	0	0	0	0	39.8	Braking/Accelerating

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40		
km	km	mm	%	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	km/hr	
0.220	0.230	7.2	35	55	3	3	3	0	0	0	3	4.7	63	30	5	3	0	0	0	0	0	36.4	Braking/Accelerating
Average		8.2	46	29	8	7	5	2	1	0	0	5.6	59	32	3	4	2	2	0	0	0	44.6	
Standard Deviation		5.8										3.4										2.9	
10th Percentile		3.9										3.2											
90th Percentile		16.8										7.5											

Survey Notes

- 1 All station values increase in the Prescribed direction
- 2 The comment for the interval indicates the value may be affected by the events.
- 3 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 Rut depth values determined using a 2m straight edge laid across a 3m lane width

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 9A1
Test Run: 1

Newcastle Street
from Blueberry Street to The End

Road Id: 9
Lane: 1
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr	
km	km	mm	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%		
0.000	0.010	13.8	0	63	13	0	0	23	3	0	0	10.0	3	68	10	20	0	0	0	0	0	13.3	Braking/Accelerating
0.010	0.020	22.2	13	13	0	0	3	68	5	0	0	9.2	0	78	23	0	0	0	0	0	0	24.3	Braking/Accelerating
0.020	0.030	3.9	98	3	0	0	0	0	0	0	0	6.1	30	70	0	0	0	0	0	0	0	30.8	
0.030	0.040	7.0	18	83	0	0	0	0	0	0	0	8.8	0	68	33	0	0	0	0	0	0	34.9	
0.040	0.050	6.5	20	78	3	0	0	0	0	0	0	8.8	20	25	55	0	0	0	0	0	0	38.0	
0.050	0.060	7.9	10	75	15	0	0	0	0	0	0	8.9	0	80	20	0	0	0	0	0	0	39.5	
0.060	0.070	5.7	36	64	0	0	0	0	0	0	0	8.9	0	80	21	0	0	0	0	0	0	40.2	
0.070	0.080	29.1	0	5	3	0	0	43	45	3	3	16.9	0	5	10	78	8	0	0	0	0	40.8	
0.080	0.090	6.3	60	28	3	3	0	8	0	0	0	7.3	33	53	8	8	0	0	0	0	0	40.7	
0.090	0.100	3.0	98	0	0	3	0	0	0	0	0	5.8	18	80	3	0	0	0	0	0	0	39.5	
0.100	0.110	3.5	95	3	0	3	0	0	0	0	0	4.6	68	33	0	0	0	0	0	0	0	36.6	
0.110	0.120	3.4	83	18	0	0	0	0	0	0	0	4.9	50	50	0	0	0	0	0	0	0	32.0	
0.120	0.130	5.8	40	55	0	5	0	0	0	0	0	6.7	15	80	5	0	0	0	0	0	0	26.9	
0.130	0.140	5.3	45	50	5	0	0	0	0	0	0	4.8	58	43	0	0	0	0	0	0	0	16.3	Braking/Accelerating
Average		7.5	51	37	2	1	0	5	4	0	0	8.0	21	57	14	8	1	5	0	0	0	36.4	
Standard Deviation		7.4										3.4										4.7	
10th Percentile		3.4										4.9											
90th Percentile		7.9										8.9											

Survey Notes

- All station values increase in the Prescribed direction

Fugro PMS Pty Ltd, ABN 64 002 245 329, Australia
A member of the Fugro group of companies with offices throughout the world

- 2 The comment for the interval indicates the value may be affected by the events.
- 3 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 Rut depth values determined using a 2m straight edge laid across a 3m lane width

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Rut Depth Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: RDR2012080-1
Client Section ID: 9A2
Test Run: 1

Newcastle Street
from The End to Blueberry Street

Road Id: 9
Lane: 2
Block: A

Station		Outer Wheelpath Rut Depth and Bin Results										Inner Wheelpath Rut Depth and Bin Results										Test Speed	Local Comment	
Start	End	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	Rut Depth	< 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	> 40	km/hr		
km	km	mm	%	%	%	%	%	%	%	%	mm	%	%	%	%	%	%	%	%	%	%			
0.000	0.010	8.3	38	25	25	13	0	0	0	0	0	3.9	80	18	3	0	0	0	0	0	0	0	25.3	Braking/Accelerating
0.010	0.020	5.6	55	35	5	3	0	3	0	0	0	2.2	100	0	0	0	0	0	0	0	0	0	26.0	Braking/Accelerating
0.020	0.030	2.3	98	3	0	0	0	0	0	0	0	2.4	93	8	0	0	0	0	0	0	0	0	27.0	
0.030	0.040	2.0	100	0	0	0	0	0	0	0	0	1.9	100	0	0	0	0	0	0	0	0	0	30.4	
0.040	0.050	2.5	95	5	0	0	0	0	0	0	0	2.8	93	8	0	0	0	0	0	0	0	0	34.7	
0.050	0.060	2.9	88	13	0	0	0	0	0	0	0	4.2	83	15	0	3	0	0	0	0	0	0	38.5	
0.060	0.070	3.7	80	20	0	0	0	0	0	0	0	2.2	100	0	0	0	0	0	0	0	0	0	41.6	
0.070	0.080	5.5	43	58	0	0	0	0	0	0	0	3.2	100	0	0	0	0	0	0	0	0	0	42.3	
0.080	0.090	7.3	8	93	0	0	0	0	0	0	0	3.9	78	23	0	0	0	0	0	0	0	0	40.9	
0.090	0.100	6.4	25	70	5	0	0	0	0	0	0	2.3	98	3	0	0	0	0	0	0	0	0	38.4	
0.100	0.110	6.9	23	75	3	0	0	0	0	0	0	2.7	100	0	0	0	0	0	0	0	0	0	35.4	
0.110	0.120	6.5	23	70	8	0	0	0	0	0	0	2.6	98	3	0	0	0	0	0	0	0	0	31.1	
0.120	0.130	6.3	38	53	10	0	0	0	0	0	0	3.2	95	5	0	0	0	0	0	0	0	0	26.1	
0.130	0.140	8.1	35	33	23	10	0	0	0	0	0	4.8	63	35	3	0	0	0	0	0	0	0	20.0	Braking/Accelerating
Average		4.8	56	42	2	0	0	0	0	0	0	2.9	94	6	0	0	0	0	0	0	0	0	35.1	
Standard Deviation		2.1										0.7										5.8		
10th Percentile		2.3										2.2												
90th Percentile		6.9										3.9												

Survey Notes

- All station values increase in the Prescribed direction

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- 5 Rut depth values determined using a 2m straight edge laid across a 3m lane width

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 1A1

Test Run: 1

Cunningham Street
from Wentworth Avenue to Geijera Place

Road Id: 1

Lane: 1

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA	Test Speed	
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.000	0.010	6.95	9.04	7.99	6.63	211	36.5	Braking/Accelerating
0.010	0.020	11.49	7.90	9.70	7.64	256	38.9	Braking/Accelerating
0.020	0.030	7.92	4.91	6.42	5.63	169	40.7	
0.030	0.040	4.31	4.47	4.39	4.04	115	41.4	
0.040	0.050	6.93	4.12	5.52	3.66	145	41.8	
0.050	0.060	7.58	5.89	6.74	5.83	177	41.8	
0.060	0.070	8.69	5.83	7.26	6.23	191	42.6	
0.070	0.080	4.13	4.57	4.35	2.74	114	43.4	
0.080	0.090	4.22	4.19	4.20	2.98	110	44.4	
0.090	0.100	7.73	2.91	5.32	4.23	140	45.1	
0.100	0.110	6.52	3.17	4.84	4.03	127	44.7	
0.110	0.120	2.27	2.18	2.22	1.97	58	43.7	
0.120	0.130	6.68	4.34	5.51	4.98	145	42.8	
0.130	0.140	3.62	3.14	3.38	3.16	88	42.1	
0.140	0.150	2.54	2.01	2.28	1.87	59	41.5	
0.150	0.160	3.93	2.93	3.43	2.20	90	41.5	
0.160	0.170	3.87	2.15	3.01	2.52	78	42.2	
0.170	0.180	6.75	3.33	5.04	3.99	132	43.8	
0.180	0.190	2.76	2.80	2.78	2.43	72	45.3	
0.190	0.200	1.55	1.12	1.34	1.08	34	46.7	
0.200	0.210	3.33	1.88	2.60	2.14	68	48.5	
0.210	0.220	3.46	2.11	2.78	2.42	73	50.2	
0.220	0.230	2.20	2.07	2.13	1.85	55	51.4	
0.230	0.240	4.04	3.28	3.66	3.04	96	52.2	
0.240	0.250	2.63	2.25	2.44	1.90	63	52.8	
0.250	0.260	2.47	2.16	2.32	2.10	60	53.3	
0.260	0.270	2.92	2.13	2.52	2.25	66	53.6	
0.270	0.280	1.44	2.56	2.00	1.68	52	53.3	
0.280	0.290	1.80	2.51	2.15	1.70	56	53.0	
0.290	0.300	4.05	3.08	3.56	2.43	93	52.9	
0.300	0.310	4.94	3.56	4.25	2.37	111	52.9	
0.310	0.320	4.33	3.21	3.77	2.72	99	53.1	
0.320	0.330	6.59	7.71	7.15	6.82	188	53.4	
0.330	0.340	4.29	4.97	4.63	4.57	121	53.6	

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA	km/hr	
km	km	mm/m	mm/m	mm/m	mm/m	counts		
0.340	0.350	6.28	5.90	6.09	5.81	160	53.2	
0.350	0.360	2.83	3.99	3.41	3.04	89	53.2	
0.360	0.370	4.74	7.06	5.90	5.18	155	53.6	
0.370	0.380	2.42	2.31	2.37	1.80	61	54.0	
0.380	0.390	2.18	2.53	2.36	1.30	61	54.3	
0.390	0.400	2.89	4.21	3.55	2.64	93	54.2	
0.400	0.410	1.47	2.79	2.13	1.88	55	54.0	
0.410	0.420	3.16	3.48	3.32	2.68	87	53.9	
0.420	0.430	2.58	2.80	2.69	2.29	70	53.8	
0.430	0.440	2.83	2.64	2.74	1.69	71	53.3	
0.440	0.450	3.28	1.11	2.19	1.91	57	52.9	
0.450	0.460	2.05	2.28	2.16	1.34	56	52.3	
0.460	0.470	1.86	2.59	2.22	1.87	58	51.6	
0.470	0.480	2.35	2.02	2.18	1.58	57	50.9	
0.480	0.490	3.59	4.46	4.03	3.53	105	50.2	
0.490	0.500	2.25	3.17	2.71	1.96	71	49.7	
0.500	0.510	4.21	2.74	3.48	2.73	91	49.3	
0.510	0.520	3.13	2.14	2.64	2.23	69	48.9	
0.520	0.530	3.39	2.59	2.99	2.81	78	48.7	
0.530	0.540	3.02	1.66	2.34	2.20	61	48.7	
0.540	0.550	1.73	1.19	1.46	1.09	37	48.8	
0.550	0.560	1.97	1.25	1.61	1.35	41	48.5	
0.560	0.570	2.47	4.92	3.70	3.42	97	47.1	
0.570	0.580	2.23	1.98	2.10	1.47	54	45.2	
0.580	0.590	2.83	2.48	2.66	1.50	69	42.6	
0.590	0.600	1.62	2.69	2.16	1.91	56	39.6	
0.600	0.610	5.57	4.35	4.96	3.58	130	36.8	
0.610	0.620	2.57	4.13	3.35	2.64	87	33.6	
0.620	0.630	6.94	7.38	7.16	6.64	188	30.7	
0.630	0.640	6.84	6.05	6.44	5.13	169	29.9	
0.640	0.650	2.62	4.88	3.75	2.75	98	30.1	
Average		3.78	3.35	3.57	2.91	93	47.4	
Standard Deviation		1.88	1.53	1.55	1.44	41	6.4	
10th Percentile		1.88	1.99	2.13	1.52	55		
90th Percentile		6.82	5.66	6.05	5.17	159		

Survey Notes

- 1 IWP - Inner Wheel Path; OWP - Outer Wheel Path; IRI_{qc} Lane - average of IWP and OWP.
- 2 NAASRA has been calculated using the IRI (quarter car). IRI (half car) is for reference purposes only.
- 3 The comment for the interval indicates the value may be affected by the events.
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 1A2

Test Run: 1

Cunningham Street
from Geijera Place to Wentworth Avenue

Road Id: 1

Lane: 2

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _q OWP	IRI _q IWP	IRI _q Lane	IRI _h Lane	NAASRA	Test Speed	
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.000	0.010	6.30	9.54	7.92	3.70	209	13.3	Braking/Accelerating
0.010	0.020	7.83	17.74	12.78	9.58	337	28.5	Braking/Accelerating
0.020	0.030	5.20	6.13	5.66	4.15	149	35.9	
0.030	0.040	6.63	9.28	7.96	5.21	209	40.5	
0.040	0.050	11.75	10.55	11.15	5.80	294	44.0	
0.050	0.060	7.00	5.20	6.10	4.82	160	46.9	
0.060	0.070	5.60	3.02	4.31	3.82	113	48.4	
0.070	0.080	2.39	2.86	2.62	1.97	68	49.4	
0.080	0.090	2.60	3.77	3.18	2.56	83	49.8	
0.090	0.100	2.82	2.65	2.74	2.05	71	49.5	
0.100	0.110	1.13	2.37	1.75	1.46	45	48.8	
0.110	0.120	1.50	2.54	2.02	1.48	52	48.1	
0.120	0.130	2.22	2.37	2.30	1.42	60	47.3	
0.130	0.140	1.97	3.14	2.56	2.21	66	46.6	
0.140	0.150	1.98	2.23	2.10	1.96	54	46.3	
0.150	0.160	2.40	3.12	2.76	2.34	72	46.2	
0.160	0.170	4.81	3.84	4.32	3.16	113	46.5	
0.170	0.180	3.58	5.34	4.46	4.28	117	47.1	
0.180	0.190	2.81	2.70	2.76	2.24	72	48.1	
0.190	0.200	2.54	3.03	2.78	2.58	73	48.9	
0.200	0.210	3.26	3.75	3.50	3.16	92	49.5	
0.210	0.220	2.41	1.75	2.08	1.68	54	50.0	
0.220	0.230	2.50	2.95	2.72	2.28	71	50.7	
0.230	0.240	3.12	2.68	2.90	2.72	76	51.6	
0.240	0.250	1.73	2.65	2.19	1.86	57	52.3	
0.250	0.260	1.81	1.94	1.88	1.63	48	52.8	
0.260	0.270	2.27	1.77	2.02	1.63	52	52.9	
0.270	0.280	1.65	1.56	1.60	1.31	41	52.7	
0.280	0.290	2.71	2.23	2.47	1.91	64	52.1	
0.290	0.300	2.53	2.89	2.71	2.30	71	51.3	
0.300	0.310	5.78	4.18	4.98	4.23	131	50.6	
0.310	0.320	4.55	2.85	3.70	2.43	97	50.3	
0.320	0.330	4.80	6.22	5.51	5.12	145	50.1	
0.330	0.340	6.65	6.54	6.60	6.03	173	49.6	

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA	km/hr	
km	km	mm/m	mm/m	mm/m	mm/m	counts		
0.340	0.350	3.05	2.45	2.75	2.53	72	49.3	
0.350	0.360	5.77	4.13	4.95	4.54	130	48.9	
0.360	0.370	4.31	2.38	3.34	2.13	87	48.8	
0.370	0.380	2.48	2.46	2.47	2.05	64	49.2	
0.380	0.390	2.78	2.62	2.70	2.14	70	49.8	
0.390	0.400	2.33	3.50	2.92	2.36	76	50.2	
0.400	0.410	2.02	1.98	2.00	1.53	52	50.5	
0.410	0.420	1.13	1.74	1.44	1.03	37	51.0	
0.420	0.430	1.44	1.56	1.50	1.24	38	51.2	
0.430	0.440	1.76	3.13	2.44	2.04	63	51.3	
0.440	0.450	0.99	2.58	1.78	1.55	46	51.4	
0.450	0.460	1.31	1.26	1.28	0.79	33	51.3	
0.460	0.470	1.92	2.51	2.22	2.01	57	51.0	
0.470	0.480	3.41	3.54	3.48	2.80	91	50.6	
0.480	0.490	2.58	2.33	2.46	2.02	64	50.2	
0.490	0.500	2.38	2.12	2.25	1.91	58	49.8	
0.500	0.510	3.36	1.82	2.59	1.91	67	49.7	
0.510	0.520	1.44	2.08	1.76	1.09	45	49.3	
0.520	0.530	1.98	1.77	1.88	1.17	48	48.7	
0.530	0.540	2.17	1.18	1.67	1.35	43	48.1	
0.540	0.550	1.30	2.09	1.69	1.13	44	47.4	
0.550	0.560	2.16	1.97	2.06	1.70	53	46.7	
0.560	0.570	2.50	2.29	2.40	2.08	62	45.2	
0.570	0.580	2.62	1.43	2.02	1.61	52	43.2	
0.580	0.590	1.74	1.34	1.54	1.14	40	40.4	
0.590	0.600	3.43	2.92	3.18	1.75	83	37.1	
0.600	0.610	5.25	3.28	4.26	3.05	112	32.6	
0.610	0.620	5.74	6.39	6.06	5.31	159	27.4	
0.620	0.630	8.41	9.36	8.88	8.63	234	24.0	
0.630	0.640	15.17	20.05	17.61	17.54	465	20.5	Braking/Accelerating
0.640	0.650	40.02	62.19	51.10	50.34	1353	10.3	Braking/Accelerating
Average		3.22	3.22	3.22	2.56	84	47.5	
Standard Deviation		2.00	1.95	1.90	1.50	50	5.7	
10th Percentile		1.44	1.74	1.69	1.24	44		
90th Percentile		5.77	6.13	5.66	4.82	149		

Survey Notes

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Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 2A1

Test Run: 1

The Causeway

from Cunningham Street to Newcastle Street

Road Id: 2

Lane: 1

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA	km/hr	
km	km	mm/m	mm/m	mm/m	mm/m	counts		
0.000	0.010	18.98	12.17	15.58	15.47	411	18.7	Braking/Accelerating
0.010	0.020	9.32	6.59	7.96	7.76	209	27.0	Braking/Accelerating
0.020	0.030	2.78	2.65	2.72	2.10	71	32.5	
0.030	0.040	1.78	3.61	2.70	2.23	70	36.0	
0.040	0.050	11.26	7.62	9.44	8.33	249	38.9	
0.050	0.060	4.48	4.83	4.66	2.90	122	40.7	
0.060	0.070	11.14	8.71	9.93	8.22	262	42.3	
0.070	0.080	4.21	4.03	4.12	3.52	108	43.6	
0.080	0.090	4.39	6.66	5.52	4.69	145	44.4	
0.090	0.100	4.98	8.03	6.50	4.37	171	44.9	
0.100	0.110	9.86	15.62	12.74	10.37	336	44.7	
0.110	0.120	6.48	10.25	8.36	6.42	220	44.1	
0.120	0.130	5.63	12.03	8.83	7.40	233	43.0	
0.130	0.140	7.16	7.59	7.38	4.86	194	41.6	
0.140	0.150	7.51	8.79	8.15	6.49	215	40.3	
0.150	0.160	11.71	14.63	13.17	11.74	348	38.2	
0.160	0.170	11.10	8.00	9.55	7.34	252	35.1	
0.170	0.180	6.33	8.31	7.32	3.92	193	31.6	
0.180	0.190	6.48	14.88	10.68	10.14	282	29.9	
0.190	0.200	8.73	14.22	11.48	11.32	303	32.1	
0.200	0.210	18.85	11.19	15.02	11.12	397	34.6	
0.210	0.220	17.44	8.36	12.90	12.30	340	35.4	
0.220	0.230	17.18	10.89	14.04	12.81	371	35.9	
0.230	0.240	3.53	7.50	5.52	3.58	145	36.6	
0.240	0.250	4.70	6.77	5.74	3.21	151	37.3	
0.250	0.260	4.21	4.48	4.35	2.55	114	38.2	
0.260	0.270	5.92	9.53	7.72	6.50	203	39.0	
0.270	0.280	4.65	10.89	7.77	5.50	205	39.0	
0.280	0.290	5.24	5.60	5.42	3.15	142	38.8	
0.290	0.300	6.46	6.56	6.51	4.31	171	37.6	
0.300	0.310	10.60	10.15	10.38	6.43	274	34.0	Braking/Accelerating
0.310	0.320	14.15	15.85	15.00	13.71	396	25.1	Braking/Accelerating

Average	7.65	8.65	8.15	6.48	215	38.4
Standard Deviation	4.45	3.47	3.40	3.39	90	4.2
10th Percentile	4.01	4.35	4.28	2.80	112	
90th Percentile	13.35	14.34	12.98	11.45	342	

Survey Notes

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Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 2A2

Test Run: 1

The Causeway

from Newcastle Street to Cunningham Street

Road Id: 2

Lane: 2

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _q OWP	IRI _q IWP	IRI _q Lane	IRI _h Lane	NAASRA	Test Speed	
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.000	0.010	24.94	17.75	21.34	20.90	564	9.4	Braking/Accelerating
0.010	0.020	5.24	3.81	4.53	4.45	119	21.2	
0.020	0.030	3.57	3.53	3.55	3.38	93	31.0	
0.030	0.040	3.49	5.15	4.32	3.88	113	36.6	
0.040	0.050	6.12	5.76	5.94	4.02	156	40.7	
0.050	0.060	3.68	4.36	4.02	2.51	105	43.7	
0.060	0.070	4.34	9.04	6.69	5.93	176	45.1	
0.070	0.080	6.16	8.24	7.20	5.11	189	45.7	
0.080	0.090	5.81	10.15	7.98	6.48	210	45.6	
0.090	0.100	4.10	4.51	4.30	3.31	113	45.1	
0.100	0.110	5.95	9.16	7.56	6.21	199	44.7	
0.110	0.120	3.59	6.42	5.00	2.80	131	44.7	
0.120	0.130	9.86	8.14	9.00	7.64	237	44.3	
0.130	0.140	6.58	7.90	7.24	7.02	191	42.4	
0.140	0.150	4.98	5.36	5.17	4.34	136	39.9	
0.150	0.160	9.71	12.41	11.06	8.30	292	36.5	
0.160	0.170	18.98	14.90	16.94	16.02	447	32.9	Braking/Accelerating
0.170	0.180	27.04	25.17	26.10	25.05	690	28.3	Braking/Accelerating
0.180	0.190	11.27	11.46	11.36	10.51	300	21.0	Braking/Accelerating
0.190	0.200	19.20	18.59	18.90	17.90	499	19.3	Braking/Accelerating
0.200	0.210	13.84	8.69	11.26	8.81	297	27.6	
0.210	0.220	6.51	11.50	9.00	8.02	237	31.9	
0.220	0.230	19.12	9.77	14.44	13.09	381	34.3	
0.230	0.240	7.74	3.21	5.48	4.26	144	35.9	
0.240	0.250	6.14	3.94	5.04	4.51	132	35.6	
0.250	0.260	6.03	6.21	6.12	3.88	161	34.9	
0.260	0.270	8.31	17.20	12.76	10.24	337	34.7	
0.270	0.280	4.66	7.36	6.01	4.71	158	33.4	
0.280	0.290	7.51	5.90	6.70	5.28	176	30.6	
0.290	0.300	14.79	13.25	14.02	13.16	370	26.3	Braking/Accelerating
0.300	0.310	34.74	27.01	30.88	30.83	817	23.8	Braking/Accelerating
0.310	0.320	36.97	42.93	39.95	33.73	1057	23.5	Braking/Accelerating
0.320	0.330	16.27	20.08	18.17	17.57	480	23.8	Braking/Accelerating
0.330	0.340	15.06	19.01	17.04	17.03	450	19.8	Braking/Accelerating

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA		
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.340	0.350	17.80	35.85	26.83	26.60	709	12.7	Braking/Accelerating
Average		6.79	7.41	7.10	5.76	187	37.8	
Standard Deviation		3.56	3.31	2.88	2.56	76	6.6	
10th Percentile		3.62	3.85	4.31	3.33	113		
90th Percentile		9.81	11.09	11.20	8.66	296		

Survey Notes

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Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 3A1

Test Run: 1

Spinifex Street

from Cunningham Street to Sandalwood Street

Road Id: 3

Lane: 1

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA		
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.000	0.010	4.87	3.88	4.38	4.34	115	18.4	Braking/Accelerating
0.010	0.020	3.34	2.67	3.00	2.48	78	24.6	
0.020	0.030	2.23	2.43	2.33	1.52	60	30.0	
0.030	0.040	6.46	7.86	7.16	3.51	188	34.5	
0.040	0.050	6.59	6.92	6.76	4.23	178	37.6	
0.050	0.060	10.43	7.69	9.06	6.83	239	38.5	
0.060	0.070	8.62	5.36	6.99	6.07	184	38.7	
0.070	0.080	4.59	5.27	4.93	4.46	129	38.4	
0.080	0.090	3.47	7.39	5.43	4.13	143	38.4	
0.090	0.100	8.68	11.37	10.02	6.03	264	39.0	
0.100	0.110	9.43	9.56	9.50	8.71	250	40.0	
0.110	0.120	5.70	8.73	7.22	5.11	190	41.0	
0.120	0.130	6.36	8.92	7.64	7.02	201	41.5	
0.130	0.140	6.75	10.83	8.79	7.31	232	41.2	
0.140	0.150	12.04	8.19	10.11	8.93	267	39.2	
0.150	0.160	8.54	9.62	9.08	7.69	239	35.6	
0.160	0.170	8.41	7.54	7.98	6.09	210	29.4	
0.170	0.180	63.25	38.08	50.66	49.29	1341	15.3	Braking/Accelerating
Average		6.98	7.52	7.25	5.63	191	36.7	
Standard Deviation		2.71	2.55	2.34	2.14	62	4.8	
10th Percentile		3.40	3.97	3.96	3.00	104		
90th Percentile		9.93	10.22	9.76	8.20	257		

Survey Notes

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Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 3A2

Test Run: 1

Spinifex Street

from Sandalwood Street to Cunningham Street

Road Id: 3

Lane: 2

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA		
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.000	0.010	8.25	4.90	6.58	6.58	173	17.4	Braking/Accelerating
0.010	0.020	4.27	3.43	3.85	2.74	101	26.1	
0.020	0.030	6.86	4.53	5.70	4.33	150	31.1	
0.030	0.040	7.94	6.35	7.14	6.63	188	34.9	
0.040	0.050	5.86	5.00	5.43	4.17	143	37.5	
0.050	0.060	2.28	6.35	4.31	3.54	113	38.5	
0.060	0.070	4.22	4.44	4.33	3.20	113	38.1	
0.070	0.080	3.90	4.63	4.26	3.54	112	36.6	
0.080	0.090	5.95	10.23	8.09	7.54	213	35.1	
0.090	0.100	5.35	7.17	6.26	5.20	165	34.3	
0.100	0.110	8.89	8.89	8.89	6.44	234	34.0	
0.110	0.120	5.68	11.84	8.76	6.66	231	34.6	
0.120	0.130	4.14	10.84	7.49	6.57	197	34.9	
0.130	0.140	10.06	13.06	11.56	8.43	305	34.6	
0.140	0.150	10.52	8.80	9.66	8.34	255	32.3	
0.150	0.160	6.13	5.52	5.82	4.04	153	29.1	
0.160	0.170	7.86	8.19	8.02	6.76	211	23.5	Braking/Accelerating
0.170	0.180	3.88	7.31	5.60	5.59	147	17.7	Braking/Accelerating
Average		6.14	7.41	6.77	5.42	178	34.1	
Standard Deviation		2.36	3.02	2.28	1.91	60	3.4	
10th Percentile		4.00	4.48	4.28	3.34	112		
90th Percentile		9.59	11.44	9.35	8.02	247		

Survey Notes

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Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 4A1

Test Run: 1

Marri Street

from Cunningham Street to Eurabbie Street

Road Id: 4

Lane: 1

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA	km/hr	
km	km	mm/m	mm/m	mm/m	mm/m	counts		
0.000	0.010	5.30	3.95	4.62	4.41	121	19.9	Braking/Accelerating
0.010	0.020	6.77	8.16	7.46	6.98	196	24.0	Braking/Accelerating
0.020	0.030	4.63	4.81	4.72	4.53	124	29.4	
0.030	0.040	4.76	4.72	4.74	3.64	124	34.1	
0.040	0.050	5.81	6.68	6.24	3.76	164	37.0	
0.050	0.060	5.33	7.38	6.36	4.63	167	36.8	
0.060	0.070	7.18	5.78	6.48	5.77	170	33.2	
0.070	0.080	9.04	6.96	8.00	5.20	211	26.6	Braking/Accelerating
0.080	0.088	26.91	22.53	24.72	23.58	654	14.3	Braking/Accelerating
Average		5.54	5.87	5.71	4.47	150	34.1	
Standard Deviation		1.03	1.16	0.90	0.85	24	3.1	
10th Percentile		4.68	4.76	4.73	3.69	124		
90th Percentile		6.63	7.10	6.43	5.31	169		

Survey Notes

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FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 4A2

Test Run: 1

Marri Street

from Eurabbie Street to Cunningham Street

Road Id: 4

Lane: 2

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA	km/hr	
km	km	mm/m	mm/m	mm/m	mm/m	counts		
0.000	0.010	10.04	6.59	8.32	6.76	219	19.0	Braking/Accelerating
0.010	0.020	3.81	3.13	3.47	2.96	91	30.0	
0.020	0.030	4.06	4.42	4.24	3.79	111	34.5	
0.030	0.040	4.80	7.48	6.14	5.12	161	36.3	
0.040	0.050	4.97	10.04	7.50	5.79	198	36.4	
0.050	0.060	3.86	4.67	4.26	1.70	112	33.9	
0.060	0.070	6.24	9.86	8.05	7.11	212	28.5	Braking/Accelerating
0.070	0.080	8.95	10.68	9.82	9.28	259	21.7	Braking/Accelerating
0.080	0.088	19.64	26.43	23.04	23.00	609	16.6	Braking/Accelerating
Average		4.30	5.95	5.12	3.87	135	34.2	
Standard Deviation		0.55	2.78	1.65	1.64	44	2.6	
10th Percentile		3.83	3.65	3.78	2.20	99		
90th Percentile		4.90	9.02	6.96	5.52	183		

Survey Notes

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- 3 The comment for the interval indicates the value may be affected by the events.
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 5A1

Test Run: 1

Blueberry Street
from Newcastle Street to The End

Road Id: 5

Lane: 1

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _q OWP	IRI _q IWP	IRI _q Lane	IRI _h Lane	NAASRA	Test Speed	
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.000	0.010	28.31	37.87	33.09	32.97	875	17.1	Braking/Accelerating
0.010	0.020	16.75	15.86	16.30	16.18	431	28.9	Braking/Accelerating
0.020	0.030	5.89	4.96	5.42	4.07	142	34.7	
0.030	0.040	6.37	4.57	5.47	4.58	144	38.1	
0.040	0.050	6.34	6.62	6.48	5.88	170	41.1	
0.050	0.060	6.67	8.89	7.78	5.76	205	43.4	
0.060	0.070	9.62	5.71	7.66	5.88	202	44.8	
0.070	0.080	6.00	3.68	4.84	3.65	127	45.9	
0.080	0.090	7.53	5.73	6.63	6.35	174	46.5	
0.090	0.100	4.97	6.07	5.52	3.67	145	46.3	
0.100	0.110	11.09	8.28	9.68	8.27	255	45.9	
0.110	0.120	6.53	11.61	9.07	6.74	239	45.1	
0.120	0.130	5.39	7.41	6.40	4.52	168	43.9	
0.130	0.140	9.45	8.18	8.82	5.90	232	42.4	
0.140	0.150	5.15	6.85	6.00	4.06	158	40.7	
0.150	0.160	10.77	6.33	8.55	7.12	225	39.6	
0.160	0.170	7.63	10.18	8.90	7.08	235	39.2	
0.170	0.180	4.91	5.71	5.31	3.86	139	39.2	
0.180	0.190	3.30	4.37	3.84	2.64	100	39.9	
0.190	0.200	2.65	2.80	2.72	2.23	71	40.6	
0.200	0.210	3.90	3.32	3.61	2.33	94	41.5	
0.210	0.220	4.54	3.06	3.80	2.94	99	42.2	
0.220	0.230	5.97	3.66	4.81	3.39	126	42.4	
0.230	0.240	4.10	3.05	3.58	3.08	93	42.3	
0.240	0.250	4.66	3.79	4.22	3.71	111	42.0	
0.250	0.260	10.10	10.03	10.06	9.05	265	41.7	
0.260	0.270	3.50	5.35	4.42	4.02	116	41.6	
0.270	0.280	4.26	3.05	3.66	3.28	96	41.6	
0.280	0.290	4.54	3.13	3.84	3.11	100	41.6	
0.290	0.300	3.76	5.84	4.80	4.45	126	41.4	
0.300	0.310	3.45	3.50	3.48	3.13	91	40.5	

Average	5.97	5.71	5.84	4.65	153	41.9
Standard Deviation	2.34	2.42	2.14	1.80	57	2.6
10th Percentile	3.49	3.06	3.60	2.88	94	
90th Percentile	9.72	9.12	8.93	7.09	236	

Survey Notes

- 1 IWP - Inner Wheel Path; OWP - Outer Wheel Path; IRIqc Lane - average of IWP and OWP.
- 2 NAASRA has been calculated using the IRI (quarter car). IRI (half car) is for reference purposes only.
- 3 The comment for the interval indicates the value may be affected by the events.
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 5A2

Test Run: 1

Blueberry Street

from The End to Newcastle Street

Road Id: 5

Lane: 2

Block A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _q OWP	IRI _q IWP	IRI _q Lane	IRI _h Lane	NAASRA		
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.000	0.010	5.66	7.79	6.72	5.50	177	28.9	
0.010	0.020	8.09	10.35	9.22	5.83	243	35.3	
0.020	0.030	6.76	8.99	7.88	5.61	207	40.1	
0.030	0.040	6.85	8.92	7.88	6.22	208	44.1	
0.040	0.050	6.80	7.99	7.40	5.63	195	46.9	
0.050	0.060	5.12	16.68	10.90	9.34	287	48.4	
0.060	0.070	13.47	11.64	12.56	7.50	331	48.8	
0.070	0.080	3.02	4.55	3.78	2.70	99	48.9	
0.080	0.090	4.20	4.34	4.27	3.24	112	48.9	
0.090	0.100	7.90	7.59	7.74	5.53	204	48.3	
0.100	0.110	6.55	6.60	6.57	5.19	173	47.7	
0.110	0.120	8.56	10.01	9.28	6.26	245	47.2	
0.120	0.130	8.12	7.38	7.75	6.04	204	46.1	
0.130	0.140	6.39	7.91	7.15	4.01	188	45.1	
0.140	0.150	8.10	7.93	8.02	4.74	211	43.6	
0.150	0.160	9.82	5.83	7.82	7.19	206	41.7	
0.160	0.170	7.28	9.02	8.15	6.22	215	39.3	
0.170	0.180	5.68	5.37	5.52	4.29	145	36.9	
0.180	0.190	6.16	3.91	5.04	3.00	132	35.7	
0.190	0.200	3.51	3.11	3.31	3.09	86	35.9	
0.200	0.210	3.76	3.47	3.62	3.13	94	38.1	
0.210	0.220	2.03	2.19	2.11	1.53	55	39.9	
0.220	0.230	3.24	2.10	2.67	2.23	69	39.8	
0.230	0.240	5.06	2.42	3.74	2.76	98	38.7	
0.240	0.250	4.87	3.28	4.08	2.38	107	37.7	
0.250	0.260	9.88	8.95	9.41	8.82	248	36.2	
0.260	0.270	5.26	6.06	5.66	3.85	149	34.3	
0.270	0.280	4.49	4.06	4.28	3.84	112	32.3	
0.280	0.290	4.53	5.06	4.80	4.06	126	31.1	
0.290	0.300	4.87	5.70	5.28	4.58	139	30.4	
0.300	0.310	2.58	5.60	4.09	3.46	107	31.6	
0.310	0.320	2.32	3.52	2.92	2.38	76	31.9	
0.320	0.330	4.53	5.03	4.78	3.63	125	30.6	
0.330	0.340	10.49	13.27	11.88	9.77	313	25.3	Braking/Accelerating

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA		
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.340	0.350	20.56	8.64	14.60	14.22	385	15.3	Braking/Accelerating
Average		5.92	6.47	6.19	4.66	163	39.7	
Standard Deviation		2.48	3.14	2.53	1.90	67	6.5	
10th Percentile		3.06	3.14	3.37	2.44	88		
90th Percentile		8.47	9.81	9.27	7.00	245		

Survey Notes

- 1 IWP - Inner Wheel Path; OWP - Outer Wheel Path; IRI_{qc} Lane - average of IWP and OWP.
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- 3 The comment for the interval indicates the value may be affected by the events.
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 6A1

Test Run: 1

Eurabbie Street

from Blueberry Street to Spinifex Street

Road Id: 6

Lane: 1

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA		
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.000	0.010	6.07	4.58	5.32	1.62	140	15.4	Braking/Accelerating
0.010	0.020	2.33	2.90	2.62	1.76	68	24.6	
0.020	0.030	2.72	2.73	2.72	1.71	71	30.7	
0.030	0.040	8.31	7.79	8.05	6.73	212	33.2	
0.040	0.050	9.08	7.04	8.06	6.77	212	33.6	
0.050	0.060	8.26	5.23	6.74	4.89	177	33.7	
0.060	0.070	6.87	10.49	8.68	6.57	229	33.9	
0.070	0.080	13.37	15.51	14.44	11.27	381	34.0	
0.080	0.090	9.24	11.51	10.38	7.66	274	34.3	
0.090	0.100	8.23	7.26	7.74	7.53	204	34.8	
0.100	0.110	5.57	7.45	6.51	5.09	171	34.8	
0.110	0.120	7.30	7.19	7.24	6.40	191	34.3	
0.120	0.130	5.49	2.71	4.10	3.22	107	32.8	
0.130	0.140	6.64	3.75	5.20	4.71	136	28.1	
0.140	0.150	14.17	14.92	14.54	10.65	384	16.7	Braking/Accelerating
Average		7.19	7.04	7.11	5.72	187	32.5	
Standard Deviation		2.87	3.80	3.18	2.60	84	3.0	
10th Percentile		3.27	2.76	3.00	2.05	78		
90th Percentile		9.21	11.31	10.04	7.63	265		

Survey Notes

- 1 IWP - Inner Wheel Path; OWP - Outer Wheel Path; IRI_{qc} Lane - average of IWP and OWP.
- 2 NAASRA has been calculated using the IRI (quarter car). IRI (half car) is for reference purposes only.
- 3 The comment for the interval indicates the value may be affected by the events.
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- 5 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 6A2

Test Run: 1

Eurabbie Street

from Spinifex Street to Blueberry Street

Road Id: 6

Lane: 2

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA	Test Speed	
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.000	0.010	7.16	5.81	6.48	5.21	171	24.4	
0.010	0.020	1.89	4.41	3.15	2.84	82	33.0	
0.020	0.030	7.43	5.12	6.28	5.22	165	35.8	
0.030	0.040	9.00	5.67	7.34	5.34	193	37.0	
0.040	0.050	3.44	6.09	4.76	2.19	125	37.7	
0.050	0.060	5.30	4.92	5.11	4.54	134	37.7	
0.060	0.070	14.63	16.65	15.64	12.50	413	37.5	
0.070	0.080	7.33	7.94	7.64	7.09	201	37.5	
0.080	0.090	9.16	8.21	8.68	8.15	229	37.7	
0.090	0.100	4.53	5.20	4.86	4.51	128	37.7	
0.100	0.110	11.10	8.33	9.72	7.91	256	37.1	
0.110	0.120	13.92	7.78	10.85	9.13	286	35.8	
0.120	0.130	5.88	5.94	5.91	4.89	155	33.0	
0.130	0.140	6.87	9.14	8.01	7.61	211	26.9	Braking/Accelerating
0.140	0.150	11.01	8.00	9.50	9.47	251	17.3	Braking/Accelerating
Average		7.75	7.08	7.42	6.12	195	35.5	
Standard Deviation		3.80	3.17	3.27	2.79	86	3.7	
10th Percentile		3.66	4.96	4.78	3.17	126		
90th Percentile		13.36	8.31	10.62	8.93	280		

Survey Notes

- 1 IWP - Inner Wheel Path; OWP - Outer Wheel Path; IRI_{qc} Lane - average of IWP and OWP.
- 2 NAASRA has been calculated using the IRI (quarter car). IRI (half car) is for reference purposes only.
- 3 The comment for the interval indicates the value may be affected by the events.
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 7A1

Test Run: 1

Sandalwood Street
from Blueberry Street to Spinifex Street

Road Id: 7

Lane: 1

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA	Test Speed	
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.000	0.010	11.37	14.44	12.90	12.09	341	18.6	Braking/Accelerating
0.010	0.020	7.92	6.72	7.32	6.54	193	27.5	Braking/Accelerating
0.020	0.030	3.11	2.91	3.01	2.36	78	34.2	
0.030	0.040	3.21	3.06	3.14	2.47	82	38.6	
0.040	0.050	2.42	3.27	2.84	2.53	74	41.6	
0.050	0.060	2.79	6.47	4.63	4.33	121	43.2	
0.060	0.070	2.70	5.85	4.28	3.45	112	43.5	
0.070	0.080	2.20	5.43	3.82	3.22	100	43.6	
0.080	0.090	1.41	4.96	3.18	3.00	83	44.3	
0.090	0.100	3.09	3.15	3.12	2.62	81	45.2	
0.100	0.110	4.66	3.53	4.10	3.41	107	45.6	
0.110	0.120	5.15	4.32	4.74	4.20	124	45.4	
0.120	0.130	2.44	4.68	3.56	3.24	93	44.9	
0.130	0.140	2.61	3.00	2.80	2.68	73	44.5	
0.140	0.150	4.89	4.76	4.82	3.65	127	44.2	
0.150	0.160	13.51	13.95	13.73	11.40	362	44.0	
0.160	0.170	8.43	9.81	9.12	6.80	240	44.8	
0.170	0.180	7.99	8.45	8.22	6.46	216	45.5	
0.180	0.190	6.39	9.50	7.94	6.21	209	45.9	
0.190	0.200	5.13	6.85	5.99	4.64	157	44.5	
0.200	0.210	8.43	9.89	9.16	8.23	241	41.8	
0.210	0.220	6.04	7.10	6.57	6.07	173	37.7	
0.220	0.230	20.66	17.55	19.10	18.77	505	32.7	Braking/Accelerating
Average		4.83	6.05	5.44	4.55	143	43.2	
Standard Deviation		2.97	2.99	2.88	2.34	76	3.0	
10th Percentile		2.40	3.05	2.99	2.52	78		
90th Percentile		8.43	9.82	9.12	6.94	240		

Survey Notes

- 1 IWP - Inner Wheel Path; OWP - Outer Wheel Path; IRI_{qc} Lane - average of IWP and OWP.
- 2 NAASRA has been calculated using the IRI (quarter car). IRI (half car) is for reference purposes only.
- 3 The comment for the interval indicates the value may be affected by the events.
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240
Testing Date: 11-May-12
Operator: Kiera Gilmour
Driver: Jason Hawken
Test Equipment: ARAN-1754

Client: Aecom
Job No: 2012080
Report No: LR2012080-1
Client Section ID: 7A2
Test Run: 1

Sandalwood Street
from Spinifex Street to Blueberry Street

Road Id: 7
Lane: 2
Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA	Test Speed	
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.000	0.010	3.29	3.99	3.64	3.23	95	27.0	Braking/Accelerating
0.010	0.020	3.16	4.79	3.98	3.30	104	35.1	
0.020	0.030	3.60	3.95	3.78	3.10	99	40.3	
0.030	0.040	1.88	3.59	2.74	2.27	71	43.6	
0.040	0.050	2.42	7.17	4.80	4.00	126	45.3	
0.050	0.060	10.38	7.06	8.72	7.37	230	46.5	
0.060	0.070	13.22	7.48	10.35	10.03	273	47.1	
0.070	0.080	7.64	4.93	6.28	5.72	165	47.7	
0.080	0.090	4.10	2.74	3.42	3.06	89	47.6	
0.090	0.100	3.74	2.03	2.88	2.26	75	47.1	
0.100	0.110	3.24	4.30	3.77	3.64	99	46.6	
0.110	0.120	5.97	5.31	5.64	4.82	148	46.0	
0.120	0.130	7.91	7.07	7.49	5.34	197	45.1	
0.130	0.140	5.94	6.61	6.28	3.39	165	44.9	
0.140	0.150	15.80	9.54	12.67	8.50	334	44.5	
0.150	0.160	10.78	7.04	8.91	7.76	235	44.7	
0.160	0.170	8.19	8.57	8.38	5.32	221	44.8	
0.170	0.180	8.58	15.24	11.91	11.28	314	44.3	
0.180	0.190	6.22	10.65	8.44	6.97	222	44.2	
0.190	0.200	13.16	16.54	14.85	14.26	392	43.6	
0.200	0.210	9.13	13.18	11.16	10.57	294	42.1	
0.210	0.220	30.65	38.28	34.47	34.37	912	39.8	Braking/Accelerating
0.220	0.230	23.74	22.30	23.02	22.18	609	36.4	Braking/Accelerating
Average		7.25	7.39	7.32	6.15	193	44.6	
Standard Deviation		3.96	3.97	3.56	3.37	94	2.9	
10th Percentile		3.09	3.50	3.37	2.98	88		
90th Percentile		13.17	13.39	11.99	10.64	316		

Survey Notes

- 1 IWP - Inner Wheel Path; OWP - Outer Wheel Path; IRI_{qc} Lane - average of IWP and OWP.
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- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 9A1

Test Run: 1

Newcastle Street

from Blueberry Street to The End

Road Id: 9

Lane: 1

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA	km/hr	
km	km	mm/m	mm/m	mm/m	mm/m	counts		
0.000	0.010	31.57	24.48	28.02	27.71	741	6.5	Braking/Accelerating
0.010	0.020	6.46	5.96	6.21	5.98	163	16.6	Braking/Accelerating
0.020	0.030	2.99	3.25	3.12	3.10	81	25.8	
0.030	0.040	2.00	2.24	2.12	1.98	55	31.7	
0.040	0.050	3.52	2.93	3.22	2.86	84	35.7	
0.050	0.060	2.13	3.59	2.86	2.18	74	38.4	
0.060	0.070	2.19	2.30	2.24	1.85	58	39.7	
0.070	0.080	1.13	1.92	1.52	1.39	39	40.4	
0.080	0.090	2.85	3.42	3.14	2.30	82	40.9	
0.090	0.100	2.40	2.67	2.54	2.13	66	40.5	
0.100	0.110	3.23	5.23	4.23	3.13	111	39.1	
0.110	0.120	2.83	2.51	2.67	2.29	69	35.8	
0.120	0.130	1.85	2.31	2.08	1.35	54	30.8	
0.130	0.140	22.67	43.29	32.98	32.58	872	25.6	Braking/Accelerating
Average		2.47	2.94	2.70	2.23	70	36.3	
Standard Deviation		0.69	0.93	0.73	0.61	19	4.9	
10th Percentile		1.85	2.24	2.08	1.39	54		
90th Percentile		3.23	3.59	3.22	3.10	84		

Survey Notes

- 1 IWP - Inner Wheel Path; OWP - Outer Wheel Path; IRI_{qc} Lane - average of IWP and OWP.
- 2 NAASRA has been calculated using the IRI (quarter car). IRI (half car) is for reference purposes only.
- 3 The comment for the interval indicates the value may be affected by the events.
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine



FUGRO PMS

LASER Profilometer Test Report - Roughness Results

Unit 7b, 26 Powers Road
Seven Hills, NSW 2147

Test Method: QT240

Testing Date: 11-May-12

Operator: Kiera Gilmour

Driver: Jason Hawken

Test Equipment: ARAN-1754

Client: Aecom

Job No: 2012080

Report No: LR2012080-1

Client Section ID: 9A2

Test Run: 1

Newcastle Street

from The End to Blueberry Street

Road Id: 9

Lane: 2

Block: A

Station		Roughness Results					Test Speed	Local Comment
Start	End	IRI _{qc} OWP	IRI _{qc} IWP	IRI _{qc} Lane	IRI _{hc} Lane	NAASRA		
km	km	mm/m	mm/m	mm/m	mm/m	counts	km/hr	
0.000	0.010	5.58	3.13	4.36	3.67	114	16.6	Braking/Accelerating
0.010	0.020	6.01	3.17	4.59	4.17	120	23.4	Braking/Accelerating
0.020	0.030	2.86	1.48	2.17	1.70	56	25.3	
0.030	0.040	2.24	1.71	1.98	1.86	51	26.0	
0.040	0.050	2.06	1.08	1.57	1.14	40	27.0	
0.050	0.060	3.41	2.85	3.13	2.66	82	30.4	
0.060	0.070	3.37	2.45	2.91	2.72	76	34.7	
0.070	0.080	2.22	1.89	2.06	1.32	53	38.5	
0.080	0.090	3.31	4.76	4.04	3.66	106	41.6	
0.090	0.100	3.89	3.10	3.50	2.28	91	42.3	
0.100	0.110	6.04	3.60	4.82	4.03	126	40.9	
0.110	0.120	4.11	2.63	3.37	2.79	88	38.4	
0.120	0.130	10.23	7.35	8.79	8.69	232	35.4	
0.130	0.140	6.33	5.50	5.92	5.77	155	31.1	Braking/Accelerating
Average		3.98	2.99	3.49	2.99	91	34.6	
Standard Deviation		2.36	1.78	2.01	2.10	53	6.4	
10th Percentile		2.22	1.48	1.98	1.32	51		
90th Percentile		6.04	4.76	4.82	4.03	126		

Survey Notes

- 1 IWP - Inner Wheel Path; OWP - Outer Wheel Path; IRI_{qc} Lane - average of IWP and OWP.
- 2 NAASRA has been calculated using the IRI (quarter car). IRI (half car) is for reference purposes only.
- 3 The comment for the interval indicates the value may be affected by the events.
- 4 Average, Standard Deviation and Percentile values exclude intervals with a local comment.
- 5 The lanes are numbered according to travel direction; 1 is the prescribed direction and 2 is the counter direction

Prepared By: Anatoly Trapeznikov

Reviewed By: James Erskine

KERB & CHANNEL CONDITION RESULTS

— - Kerb & channel rating ≥ 3



B

TECHNICAL NOTE TO THE COST BENEFIT ANALYSIS

EAST LAKE SITE PREPARATION FEASIBILITY STUDY

This note provides additional technical information that is relevant to the outcomes of the CBA outlined in Section 7 of the main report. It provides further details about the CBA approach, the data sources used to support the analysis, and the assumptions used to assess the net benefit of each option.

General economic assumptions

The key economic assumptions applied to all models under the base scenario have been summarised in Table 1 below. Details used under various sensitivity scenarios have been discussed in Section 0.

Table 1 Key economic assumptions

Parameter	Units	Value
Appraisal start year	Year	2013
Price year	Year	2012
Appraisal duration	Years	30
CPI	N/a	N/a
Real discount rate after tax	%	7%

Source Based on AECOM's analysis

Total area of land for remediation

The following tables provide the total land take of site development after remediation. As discussed in Section 7 the same planning development framework (PDF) the East Lake precinct under remediation options 1 to 3 was used, with a separate PDF applied under remediation Option 4.

The detailed breakdown of each of the PDFs in terms of land take was provided to AECOM by Simpson+Wilson Architecture and Design, and has been provided in the table below for remediation options 1 to 3.

Table 2 Option 1 to 3 - land take details (m²)

Type	Classification	Area (m ²)
Residential	Total apartment lots	
	Mews	
	Terrace	
	Compact	
Commercial	Commercial	
Total development land take		

Source Simpson+Wilson Architecture and Design 2012

Table 2 provides the detailed breakdown of land area (against the PDF) for Option 4. This information was also provided to AECOM by Simpson+Wilson Architecture and Design specifically for the purposes of this project.

Table 3 Option 4 - land take details (m²)

Type	Classification	Area (m ²)
Residential	Multi Unit 6 Storeys (footprint only)	
	Multi Unit 3 Storeys	
	Mews	
	Terrace	
	Compact	
Mixed Use / commercial	Commercial in Mixed Use	
	Pure Commercial	
Total development land take		

Source Simpson+Wilson Architecture and Design 2012

Determination of remediation costs

Physical clean-up costs

The cost of remediation under each option was determined by AECOM's PCC team. The total cost and key cost items under each option have been presented in Table 4 for the 100% fill volume being ACM impacted scenario.

Table 4 Estimated values for physical clean-up costs (000's) – baseline costs estimated at a 100% fill volume

Cost item	Option 1	Option 2	Option 3	Option 4
Preliminaries				
Site Set Up				
Onsite Works				
Site Supervision				
Total				

Source Based on estimates by AECOM's PCC team, 2012

The total cost and key cost items under each option have been presented in Table 5 for the 60% fill volume being ACM impacted scenario.

Table 5 Estimated values for physical clean-up costs (000's) – baseline costs estimated at a 60% fill volume

Cost item	Option 1	Option 2	Option 3	Option 4
Preliminaries				
Site Set Up				
Onsite Works				
Site Supervision				
Total				

Source Based on estimates by AECOM's PCC team, 2012

The total cost and key cost items under each option have been presented in Table 6 for the 10% fill volume being ACM impacted scenario.

Table 6 Estimated values for physical clean-up costs (000's) – baseline costs estimated at a 10% fill volume

Cost item	Option 1	Option 2	Option 3	Option 4
Preliminaries				

Cost item	Option 1	Option 2	Option 3	Option 4
Site Set Up				
Onsite Works				
Site Supervision				
Total				

Source Based on estimates by AECOM's PCC team, 2012

Other costs

A discussion relating to the other costs considered in the CBA but not analysed in detail, is provided in the body of the report.

P50 / P90 modelling of costs

Probability modelling is undertaken using @Risk software package to simulate the probability distributions of costs. This process is in accordance with the 'Best Practice Cost Estimation Standard' published by the Australian Department of Infrastructure and Transport¹ in 2011.

Simulation performs risk analysis by building models of possible results and substituting a range of values for any of the factors in a model that has inherent uncertainty. It then calculates the results over and over, each time using a different set of random values from the probability functions. Depending upon the number of uncertainties and the ranges specified for them, a simulation could involve thousands or tens of thousands of recalculations before it is complete and produces a distribution of possible outcomes.

Determination of remediation benefits²

This section outlines the approach and assumptions used to estimate the value of the post-remediated East Lake precinct. The objective of estimating the precinct's value of land after remediation was to use them as benefit inputs to the CBA in order to determine the preferred option out of the four proposed approaches when compared against their respective costs.

As such, it should be noted that the land value estimation undertaken by AECOM does not follow the Australian Property Institute's ANZ Valuation Property Standards, and should not be relied upon as indicative sale prices of land of the post-remediated East Lake precinct.

That said, for the purpose of undertaking the options analysis across the four remediation options, the land values estimated through our approach is sufficient, since the same principles estimation was applied to all options. Provided a consistent approach is used to estimate land values for all options, the CBA outputs allows for direct comparison across each of the options.

In the following sections, we provide discussions on:

- land product classification (raw or developed)
- methods of land valuation
- land value estimation
- adjustment factors to account for unique characteristics of the site.

Land product classification

The type of land product that will result from the remediation will determine its value, and therefore, the sale price determined by the property market. For the purpose of this analysis, two types of land product were defined:

- 1) raw land – unserviced land released to the private sector for servicing and sale
- 2) developed land – land with buildings and infrastructure.

The attributes of these two types of land are shown in Table 7.

² We have also assumed that the site is not creating a 'negative' value, although in reality, there may be some ongoing monitoring costs associated with the precinct.

Table 7 Land types

	Raw land	Developed land
Remediation (if required)	✓	✓
Serviced (water and sewerage)	☒	✓
Dwellings and buildings	☒	✓

Source AECOM

The development of the site, including the construction and sale of buildings as well as the provision of services, should follow the remediation; however, the benefits and costs of that development will be borne by the developers. Therefore, the land type to be created by the remediation program is considered to be englobo land.

In the ACT, the Local Development Agency (LDA) is responsible for land releases and manages the release of land for residential, commercial, industrial and community purposes by:

- releasing serviced sites from its own greenfield estates, urban renewal and infill locations;
- partnering with others in joint venture developments; and
- releasing large parcels of raw land directly to the private sector (englobo releases).

The state of the post-remediation East Lake site as an unserviced, government-owned land suggests that the LDA will be responsible for the release of the site to developers. This assumption is supported by the LDA's *Indicative Land Release Program 2012-13 to 2015-16* publication which states that the LDA plans to release residential land at East Lake over from 2013-14 onwards.

Methods for valuing land

There are several methods for calculating the base value of the post-remediation East Lake site as raw land. These methods include:

- direct comparison
- summation
- capitalisation of net income.

A description of each of these methods, along with the advantages and disadvantages for the valuation of the East Lake site, is shown in Table 8.

Table 8 Land valuation methods

Valuation method	Description	Advantages	Disadvantages
Direct comparison method	Comparing and contrasting sales of similar properties and the subject property.	- Able to be used to value non-developed land	- Assumes other sites are comparable to East Lake site
Summation method	Adding unimproved value of the land added to the value of the improvements on the land	- Values based on specific amenities of property	- Only applicable to developed sites
Capitalisation of net income	Applying an investment yield to the property to work out rental income which is then discounted to determine market value	- Value based on actual yield of property - Useful for planning investment properties	- Only applicable to developed sites - Requires rental information for similar properties

Source Chan, 2000

The direct comparison method is the most appropriate method as it is only method that is applicable to raw land rather than developed sites.

Land value estimations

Per square metre land value

The potential land value of the post-remediation East Lake precinct which reflects the prescribed development plans outlined within the PDFs were calculated by multiplying the total area of various residential, commercial and light industrial mixes by corresponding *per square metre values of land*.

The benefit of this approach in conjunction with the application of land value adjustment factors (discussed in Section 0 below) is that it allows for a broad estimation of aggregate land values in the context of significant uncertainties around the details of design and commercial value of the planned development of East Lake. General assumptions pertaining to the value of land at the East Lake precinct can be checked through the process of sensitivity analyses.

Value of land per square metre for various housing and commercial mixes was extrapolated from land sales data that is publically available on the LDA website, and has been show in Table 9 below (LDA, 2012). For the purpose of this analysis, only the data corresponding to sales made between June 2010 and October 2012 was used.

Table 9 LDA average values for raw land by land use category

Land use type	Value per square metre (\$/m ²)
Commercial	
Community	
Englobo	
Industrial	
Mixed-Use	
Multi-Unit Residential	
Residential	
Terrace	
Mixed-Use / Childcare	

Source LDA land sales data, June 2010 - October 2012

Total unadjusted value of land

Using the per square metre value of land outlined above, the total unadjusted value of land under the two PDF options was determined as shown in Table 10.

Table 10 Total value of land under each PDF – unadjusted

PDF applied	Total unadjusted land value (\$m)
PDF applied to options 1 to 3 (see Table 2)	
PDF applied to Option 4 (see Table 3)	

Source AECOM based on LDA 2012

The difference in the total unadjusted land value is due to the difference in land available as well as the mix of land types under each option.

Adjustments to land values

The land values provided by the LDA were adjusted based on the factors unique to the East Lake site. A critical factor is the proximity of East Lake to transport services, facilities and key landmarks (Lake Burleigh-Griffith).

Other factors that are anticipated to have some level of impact on the East Lake land values which were not directly modelled (some are tested in the sensitivity analysis) are discussed below.

Proximity to transport services, facilities and key landmarks

While rental and purchase prices in the ACT for houses and apartments are generally about 30 per cent lower compared with other state capitals such as Sydney and Melbourne, like the other capital cities, there is a much higher premium to live in inner city areas which are in close proximity to urban facilities and transport.

The reason for this is that, assuming all things being equal, economic theory suggest that consumers are willing to pay a premium for accessibility to central ‘hubs’ as it allows them to reduce travel time, and spend the ‘saved’ time on other activities such as leisure – an activity which many place a high value on (Krugman, 1994 and Infrastructure Australia, 2010). Many people prefer to trade-off commute time for time spent with family, at home and for lifestyle choices (ESDD, 2012). A fully remediated site with residential dwellings could be expected to be valued at a premium price due to their sought after location.

East Lake was identified in the *Canberra Spatial Plan* (2004) as a ‘sustainability showcase redevelopment site for residential and mixed uses’ due to its proximity to the central employment areas and major transport routes of Canberra. This has been reaffirmed in the updated *ACT Planning Strategy 2012*. The Site is located within close proximity to the Canberra Civic area and the Parliamentary Triangle, and has been identified to form part of the residential intensification of inner Canberra under the *ACT Planning Strategy*.

A wetland of significance (Jerrabomberra Wetlands Nature Reserve), transport facilities (Monaro Highway, the Canberra International Airport and Canberra Train Station), iconic and highly valued retail and commercial areas (Kingston, Manuka, Fyshwick Fresh Food Market) and Lake Burley Griffin form the positive and attractive context for the site. East Lake has the potential to be regarded as Canberra’s most prestigious region, further enhanced by the recent development of Kingston Foreshore, a new residential, commercial and arts precinct.

As shown in Table 11 and graphically represented in Figure 1 and Figure 2 below, a high-level assessment of comparable real estate values between the suburbs of Kingston (used as a proxy for East Lake since it is located adjacent to the precinct) and suburbs further away from Parliament House³ clearly demonstrates that housing sold in Kingston is considerably more expensive. Belconnen, Gungahlin and Harrison were chosen as the comparative suburbs since a large proportion of Land Sale prices sourced from LDA were for sales made in these locations (detail discussion provided in Section 0).

Table 11 Average house values – Kingston and selected ACT suburbs

Suburb	1 bedroom	2 bedroom	3 bedroom	4 bedroom	Average
House					
Belconnen					
Gungahlin					
Harrison					
Kingston					
Belconnen					
Gungahlin					
Kingston					

³ Parliament House was used as a proxy for the Canberra’s ‘hub’ since major government offices such as Department of Foreign Affairs and Trade, Australian Treasury and other major public facilities such as the National Library and the National Art Gallery are located within a radius of 500 metres from this location. Furthermore, the Canberra Civic area where many of the city’s retailers concentrate, is also within one kilometre away from Parliament house.

Figure 1 Average house values – Kingston and selected ACT suburbs



Figure 2 Average unit values – Kingston and selected suburbs



Impact of stigma

The impact of stigma on the land values of options was calculated during the sensitivity analysis stages of the CBA. Additional detail about this is outlined below

.Adjusted value of land

The price differential observed between Kingston's property values and that of the comparison suburbs were applied to the unadjusted total value of land presented in Table 10, to obtain the *adjusted value of land* at the post-remediated East Lake precinct.

These have been summarised in Table 12 below.

Table 12 Adjusted values for raw land by land use category – East Lake

Land use type	Value per square metre (\$/m ²)
Commercial	
Community	
Englobo	
Industrial	
Mixed-Use	
Multi-Unit Residential	
Residential	
Terrace	
Mixed-Use / Childcare	

Source Adjusted from LDA land sales data, June 2010 – October 2012

Unquantified factors

Table 13 describes the other factors that impact land values that were considered by AECOM but unquantified for valid reasons. These factors are categorised as economic, financial, social, environmental and legal benefits.

Table 13 Other factors that impact on land values

Description	Reasons why factors have not been assessed in more detail
Economic and Financial Benefits	
Potential avoided capital expenditure under each of the options	- A particular remediation option may enable greater avoided capital expenditure for infrastructure in the area. The preliminary nature of the remediation options means there is insufficient information to determine if any of the remediation options deliver material avoided capital expenditure benefits compared to the other options.
Change in property and land values in surrounding suburbs	- Remediation may increase in change in property and land values but the scope of work did not allow for detailed quantification of broader benefits to state and national economies.
Generation of additional employment during remediation and post-remediation for property construction	- It is unclear whether the remediation will have a material impact on the work force required for operation and construction. As there is not a definitive source of funding for

Description	Reasons why factors have not been assessed in more detail
	the remediation work it is difficult to determine if an additional workforce will be required beyond the current ACT workforce for remediation.
Contribution to regional and state economies	<ul style="list-style-type: none"> - The analysis does not include the quantification of broader economic output benefits to the state and national economies. The reason for this is because even if the remediation of East Lake did not go ahead, an assumption can be made that government expenditure would be made in other projects which will contribute to territory and national economies by the same amount saved from not remediating East Lake.
Demand for Alternative Uses	<ul style="list-style-type: none"> - After remediation a site may longer be amenable to the original use nor other uses. Demand for other uses in a particular area must be evaluated as if other uses are apparent and in demand they may be less effect on marketability and value. - Also this factor is considered in other areas of the feasibility study.
Extent and Nature of Contamination	<ul style="list-style-type: none"> - Contaminated area should be compared to typical, unencumbered property and differences established. - Also this factor is considered in other areas of the feasibility study.
Type and Location of Properties	<ul style="list-style-type: none"> - Location of property can make a significant difference in the amount of utility lost due to environmental contamination with contamination within an urban centre likely to not be tolerated. - Also this factor is considered in other areas of the feasibility study.
Social Benefits	
Decreased public health problems	<ul style="list-style-type: none"> - This benefit relates more directly to the overall expected benefits rather than benefits associated with varying remediation options.
Decreased health risks between differing remediation options	<ul style="list-style-type: none"> - It could be expected that there are differing levels of exposure to asbestos and contamination to personnel undertaking remediation work depending on the remediation options. However such differences are extremely difficult to value and it could be expected that any option will be undertaken with the utmost regard to mitigating any health risks (Chan, 2001).
Increased opportunity for social, recreational and education activities on the site as well as increased opportunity for services and facilities	<ul style="list-style-type: none"> - This benefit relates more directly to the overall expected benefits from the development of the site, rather than the benefits associated with varying remediation options. - It is difficult to quantify of these benefits for each of the remediation options.
Increased social amenity and increased open space	<ul style="list-style-type: none"> - Amenity and open space values are not reflected in the model.
Environmental Benefits	
Decreased threats to ecosystem.	<ul style="list-style-type: none"> - Overall there may be improved environmental outcomes due to the remediation of the area and the model specifically includes greenhouse gas considerations.
Environmental Justice (Idea that no community should bear disproportionate amount of environmental burden (Eady, 2007))	<ul style="list-style-type: none"> - This benefit would be important to quantify if there were various different sites in consideration rather than differing options for one site. It could be expected that any of the four remediation options will reduce the future population's environmental burden.
Legal Benefits	

Description	Reasons why factors have not been assessed in more detail
Decreased legal liability (A remediator will need ensure that the best model has been utilised to counter any potential liability)	- Quantifying legal liability is an extremely complex process often with immaterial results. It is difficult to forecast (and value) the legal costs associated with undertaking a poor remediation process. It is also difficult to judge with whom any potential liability may lie i.e. the developer, government, or new land owner (Chan, 2001)

Source Based on AECOM's analysis

Summary of remediation benefits

Table 14 provides a summary of the benefits arising from the remediation actions proposed for each option.

Table 14 Remediation benefits

Benefits	Quantified
Sale of land	✓
Change in property and land values in surrounding suburbs	☒
Generation of additional employment during remediation and construction	☒
Contribution to regional and state economies	☒
Decreased public health problems	☒
Decreased health risks between differing remediation options	☒
Increased opportunity for social, recreational and education activities on the site as well as increased opportunity for services and facilities	☒
Increased social amenity and increased open space	☒
Decreased threats to ecosystem	☒
Environmental Justice	☒
Decreased legal liability	☒

Note ✓ = Quantified benefit; ☒ = Benefit assessed but not able to be accurately quantified

Timing

The assumed timeframes relating to each of option is shown in Table 19. The timeframes for which land becomes available for sale will be an important determinant in how land values for each option are realised by the ACT Government.

The timing of land release following remediation has been derived from discussions between the design team and ESD. At this stage, it is important to note the highly indicative nature of these timeframes. The duration of remediation was provided for the economic appraisal by the AECOM PCC team.

As shown, for the CBA, it was assumed that the East Lake precinct will sell immediately after the site goes on sale to property developers 18 months after the completion of remediation under each Option.

Table 15 Assumed timing of land release and sale

Option	Remediation duration (from 1 st July 2013)	Land holding period (from end of remediation)	Assumed land sale date
Option 1	22 months	18 months	31 st October 2016
Option 2	28 months	18 months	30 th April 2017
Option 3	20 months	18 months	31 st August 2016
Option 4	10 months	18 months	31 st October 2015

Source AECOM

Sensitivity analysis

Real discount rates

Potential variability in the future discount rates were sensitivity tested using standard ACT Treasury guidelines. The high and low discount rate scenarios have been summarised in

Table 16 Sensitivity testing of real discount rates

Scenario	Base	Low	High
Real discount rate (%)			

Source AECOM

Post-remediation stigma

A contaminated property is similar to ordinary property except that the property is polluted by one or more hazardous substances. Even following remediation, the value of a contaminated property may be affected by stigma. The perception of potential problems may impact on potential purchasers, occupiers, developers, and financiers. Apart from environmental risks, there is also the possibility of future financial and legal liabilities.

Calculating the impact of post remediation stigma on the potential land values of the East Lake site is difficult. Literature on the impact of stigma reveals a number of potential methods and a simplified version is shown in the following formula:

$$V_c = V_u - L - C_r - S$$

- Where
- V_c = contaminated value
 - V_u = uncontaminated value
 - L = loss due to reduced income/productivity and/or legal liabilities
 - C_r = remediation and related cost
 - S = stigma impacts (Chan, 2000).

The formula can be amended to show that the value of the remediated land (contaminated value plus the remediation costs) is the value of unimpaired land minus the potential losses to income/productivity as well as the stigma impacts.

$$V_c + C_r = V_u - L - S$$

As identified in Chapter 10 of this report, various geotechnical and environmental investigations have been conducted at the Site to assess contamination present and the potential impacts development on the Site may have on human health and the environment. Summarised, the investigations revealed six areas of potential contamination in the soil as well as possible contamination in groundwater, landfill gas and surface water (especially in relation to the potential for asbestos migration). Potential types of contamination included:

- contamination from leakages or spills associated with fuel tanks or spills of hydrocarbon fuels
- contamination from waste oil and fouled ballast
- contamination with heavy metals from landfill leachate
- waste fill materials exposed in cuttings including potential asbestos cement board
- fuel and chemicals stored on site.

A survey of land valuers on the potential discount on unimpaired land values as results of stigma, by previous land use at East Lake, is shown in Table 17

Table 17 Reduction in land values (stigma) based on previous land use

	Average	Low	High
Asbestos			
Residential			
Commercial			
Industrial			
Landfill Sites			
Residential			
Commercial			
Industrial			
Oil Production, Treatment and Storage			

	Average	Low	High
Residential			
Commercial			
Industrial			
Average			
Residential			
Commercial			
Industrial			
Industrial			

Source Chan, 2000

The average stigma has been calculated based on the previous use for the East Lake site for use as sensitivity analysis. The sensitivity analysis

Table 18 Sensitivity analysis - stigma and remediation options

Option	Remediation	Stigma Scenario
Option 1	Clean environmental hotspots, cap uncompacted fill area as required. Management of general geotechnical and environmental issues would be managed by individual Site developers	Average
Option 2	Remediate the whole of the fill for geotechnical and environmental contamination by excavation, removal of unsuitable materials and replacement of the soil materials as controlled fill	Low
Option 3	Clean environmental hotspots and use partial excavation in conjunction with ground improvement such as impact rolling to improve the geotechnical properties of the site followed by adequate controlled fill capping	Average
Option 4	Excavation of clean fill material from South Eastern portion of the site and excavation of contaminated and geotechnically unsuitable fill material from the central portion of the Site. Contaminated and geotechnically unsuitable fill material is transported and placed within the South Eastern portion of the Site where upon completion of the excavation is capped with a 1m thick layer of clean fill material.	High

Source AECOM

Future growth of the housing market

The model incorporates sensitivity for potential changes in the housing market on a low; medium; and high basis. This is important to consider as a decrease or cooling period in the housing market could result in reduced benefits from the remediation. This could result in costs outweighing the benefits of remediation.

The potential for limited future growth of the ACT property market will be affected by supply and demand cycles of residential property. The demand drivers for residential property can be summarised as economic growth and interest rates, population growth and employment.

Currently in Australia and in particular in the ACT, there is an undersupply of dwellings. Across Australia at June 2011, there were fewer dwellings than required by the total population with a shortfall of around 100,000 dwellings. A key driver of this undersupply has been population growth with recent record net overseas migration inflows, which have not been met with a commensurate increase in new dwelling construction (BIS Shrapnel, 2012).

In the ACT historically, undersupply of housing has been driven by population growth (which remains well above the longer term average of 1 per cent and 1.9 per cent because of migration) and economic growth (in the ACT prolonged periods of economic growth above 2 per cent have supported employment and population growth) (LDA, 2012a). While currently it is estimated that there is a small surplus of properties in the ACT housing market, the ACT Government is proposing to maintain residential land supply over and above the anticipated level of

demand in order to further absorb any further unmet demand (especially for the shortfall in detached housing blocks) and to assist with housing affordability for both home buyers and renters (LDA, 2012a).

Table 19 Comparative Estimates of the ACT's Housing Supply/Demand Balance

Report	ACT Housing Status
National Housing Supply Council: 3 rd State of Supply Report <i>(released in December 2011)</i>	600 dwelling surplus
Residential Property Prospects 2011-2014 – Report by BIS Shrapnel <i>(released in December 2011)</i>	100 dwelling surplus
The Housing Industry Association Housing to 2010 Report <i>(released September 2011)</i>	215 dwelling surplus

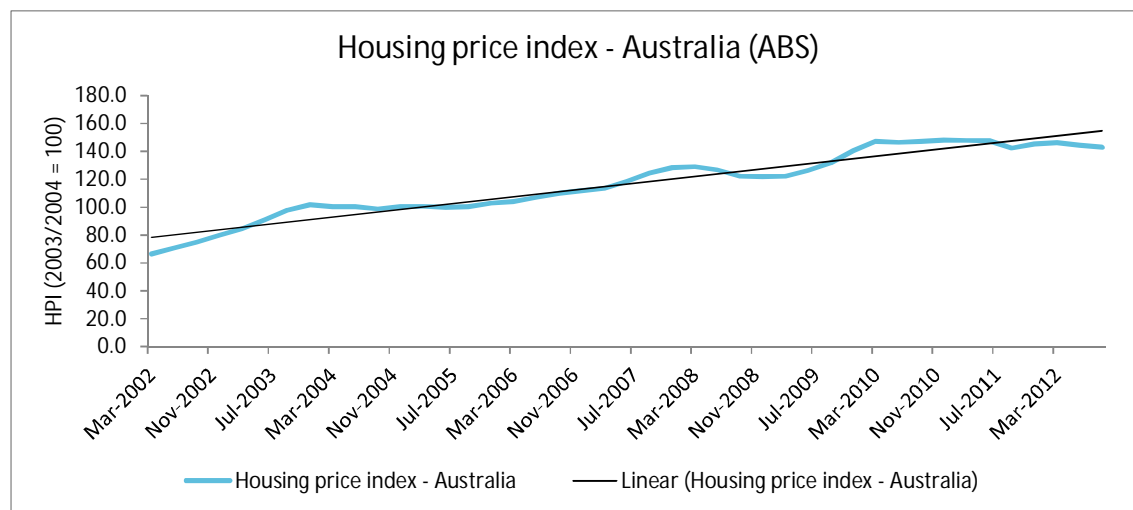
Source LDA, 2012.

Housing price growth scenarios

In light of current residential market deficiency in the ACT and Australia, which will underpin tight vacancy rates and rental growth, at a fundamental level, there is expected to be some moderate house price growth over the next five years (BIS Shrapnel, 2012). While there are constraints to the Australian housing market this is not expected to be sufficient to drive a substantial downturn in prices in this environment.

As shown in Figure 3, there has been a steady rise in the housing price index in Australia. The mean year-on-year housing price index growth rate for the five years to September 2012 has been 0.931 per cent per annum. Whilst this growth rate was used as the base case scenario for housing price increase in the short term future and a high growth scenario pegged to this value, a worst case scenario of a -0.5 per cent growth rate was used in the low growth scenario, in order to assess the impact of an unlikely declining real estate market.

Figure 3 Australian housing price index – historical trend



Source ABS 2012

Table 20 below summarises the base case, low and high scenarios of housing price growth employed in the sensitivity analysis.

Table 20 Low, medium and high scenarios of housing price growth

Scenario	Per annum growth rate (%)
Base	
Low	
High	

Source AECOM

High and low remediation costs

Potential variability to remediation costs were sensitivity tested under high and low remediation cost scenarios. The physical costs used under each of the scenarios have been summarised in Table 4 for the high cost scenario and Table 6 for the low cost scenario in Section 0 of this Appendix. Each of the cost scenarios was provided by the AECOM design team under the assumptions that under the high scenario, 100 per cent of the fill volume would be ACM impacted, and under the low scenario, 10 per cent of the fill volume would be ACM impacted.

Remediation duration

The based case remediation duration for each of the options is shown in the table below

Table 21 Remediation duration (base case)

Option	Base (months)
Option 1	22
Option 2	28
Option 3	20
Option 4	10

Source AECOM

The duration of the remediation will have implications for the eventual sale date so sensitivity analysis will be undertaken on the impact of increasing the duration of the remediation. The two scenarios are:

- Moderate duration overrun (20% increase in duration)
- Major duration overrun (50% increase in duration).

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